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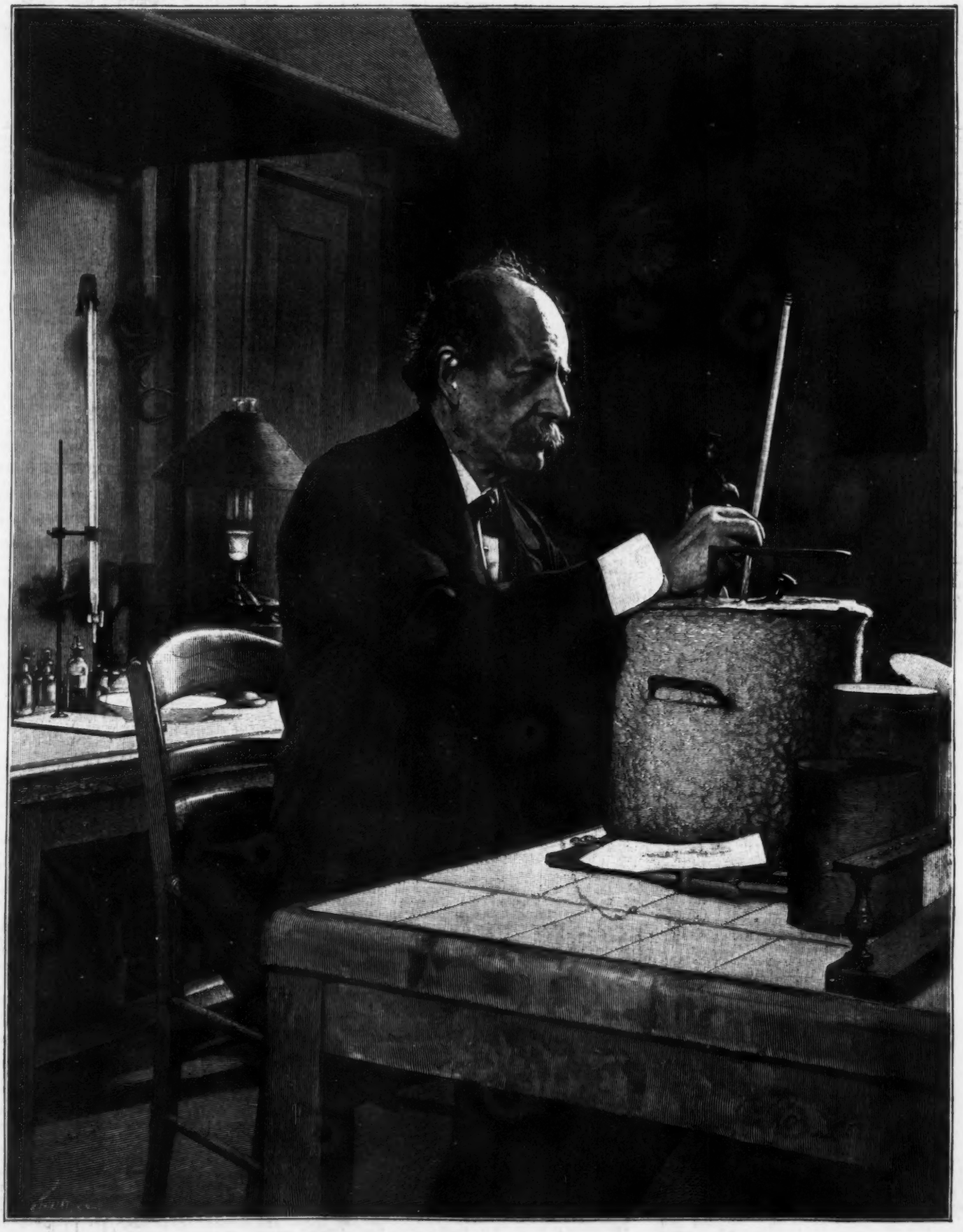

M. BERTHELOT IN HIS LABORATORY AT THE COLLEGE OF FRANCE.

M. BERTHELOT.

In spite of his seventy-four years, M. Berthelot is still pursuing at his home the long series of observations that he has been engaged in for half a century.

He shows at a glance that he is a scientist. His typical physiognomy well corresponds to the special vocation which has made of him one of the greatest chemists of modern times. He began in 1851 as simple preparator to Balard, at the College of France, of which he was to become one of the pillars and glories. Promoted to be master in his turn, he revolutionized the science to which he had devoted himself, and upset and demolished the old theories that had been accepted up to Berzelius, and according to which it was believed that, in living nature the elements obeyed distinct laws, and a mysterious force called "vital." In reconstituting organized bodies by methodical and rational methods, through the intervention of physical and mechanical forces, he demonstrated that the same laws govern all matter, animate and inanimate, and thus, upon the positive basis of synthesis, he solidly built up organic chemistry.

When we think of the amount of work that such an undertaking represents, and of the number of meditations, calculations and experiments that it must have cost, we can scarcely imagine M. Berthelot anywhere else than in his laboratory, surrounded with his apparatus, and tête-à-tête with the material of which he is unveiling the secrets; and if perchance he momentarily leaves this post of observation and combat, it is doubtless only to deliver his magistral lectures at the College of France, at the School of Pharmacy and at the High School, or to address communications to the Academy of Sciences, of which he was elected a member in 1873, or to some other of the innumerable societies that have the honor of reckoning him among their associates. To think thus would be an error. To pretend to confine M. Berthelot to the limits of his specialty would be to forget the complex character of his personality, which is itself the "synthesis" of several different elements, constituting a single Berthelot in three persons.

Along with the great chemist, there is the philosopher and the public man. Berthelot the philosopher announced himself at an early period, since upon the benches of the Lyceum of Henri IV. he obtained a prize of honor at the general competition of 1846. He kept up a friendly communication with Renan, and despite notable divergencies of doctrine, exchanged with him quite a spicy correspondence, which was published in 1898.

But the absolute cellular regime would not have agreed with the third element, which in M. Berthelot manifests its existence by an imperious need of expansion. Endowed with wonderful activity, and realizing almost the miracle of ubiquity, M. Berthelot, between two experiments, between two meditations, has always been able to spare time to go out in order to get fresh air.

So, M. Berthelot sometimes leaves his laboratory while conquered matter continues to operate in the crucibles and closed vessels.

In 1881 he went to take his seat at the Luxembourg, having been elected perpetual senator by the Upper Assembly.

Not content with being "somebody" in the universal domain of science, he aspired to become "something" in the parliamentary hierarchy.

Certainly a scientist of such breadth was not out of place as head of the University; but, it was impossible for people to suppress a feeling of surprise when he was seen between 1894 and 1895 occupying the position of Minister of Foreign Affairs at Quai d'Orsay. There were organisms here that he did not know much about, and he showed that he was not very familiar with diplomatic combinations. After this experience he was only too glad to return to his beloved studies. In politics the eminent senator has nothing of the wild theorist. His republicanism is rather Athenian than Spartan.

Let us add that M. Berthelot is one of the most titled men in France. It would take a column to enumerate all the honors that have been heaped upon him, and all the foreign societies to which he belongs, and all the decorations that he has received. And yet to this marshal of science there was something wanting, he was not a member of the Academy. This honor has now been accorded him, however, for last month he was admitted to a seat among the forty "Immortals."—For the engraving and the above details we are indebted to L'Illustration.

PHOTO-CHEMICAL INDUCTION.

LUGGIN and Luther have shown that when a halogen compound of silver is exposed to light for long periods of time, a state of chemical equilibrium will be finally reached which is defined for every degree of intensity of the light by the manifestation of a certain potential (gas-pressure, E. M. F., strength of solution) in the halogen liberated. This state of equilibrium is not attained in practical photography, first, because the exposure is too short; second, because the halogen disappears partly by diffusion, and partly by combination with the emulsifying material of the film. The sensitiveness of a plate is measured by the photochemical effect produced by a certain exposure; and as the limit of the action is reached when the halogen exhibits its equilibrium potential, it follows that everything which reduces the actual halogen potential below its equilibrium value increases the photochemical effect, or the sensitiveness of the film. For this reason a substance like gelatin, which is readily oxidizable, should, and as a matter of fact does, yield a more sensitive emulsion than such a body as collodion, which is indifferent toward halogens; because the free halogen that would interfere with the action of the light is brought to a lower potential by combining with the gelatin in part. When, as in practice, silver bromide is emulsified in gelatin, the ideal process outlined above is complicated by two opposing forces: on the one hand, diffusion of bromine into the atmosphere is retarded by the colloid, which tends to reduce sensitiveness; on the other hand, bromine combines with the colloid, which tends to increase sensitiveness. Since, however, the second action is far more important than the first, a gelatin plate is highly sensitive; but that the former process is somewhat inhibitory the following experiment shows.

A uniformly coated gelatin plate was cut in two and placed in a stereoscopic camera, one half with the film toward the lens, the other half with its glass in front. Before the film-exposed (i. e., the former) plate was fixed a sheet of glass not touching the film, in order to equalize the intensity of the light which reached each portion of the sensitive stratum. The whole was given a short exposure to a brightly lighted wall, and both halves were then simultaneously immersed in a very weak, slow, developer. The glass-exposed plate gave a distinctly weaker image, which appeared and grew almost equally throughout the entire thickness of the film; the film-exposed plate developed more rapidly, but the image was confined at first to the outer surface of the film, and it penetrated but slowly toward the glass. The concentration of the deposit upon the front surface of the film-exposed plate and its regular distribution through the film of the glass-exposed plate were shown clearly by the microscope; and by measurement it was found that the former contained 410,000 granules of silver per sq. mm., as against 325,000 in the latter. These results correspond with theory: in the film-exposed plate the light is strongest where diffusion is most easy; as the light penetrates and becomes weaker, so the film becomes less sensitive by the obstacles opposed to the escape of the halogen, therefore the action is essentially confined to the immediate surface. In the glass-exposed plate, on the contrary, the light is strongest where the film is at least sensitive; and as the light becomes weaker, so the film becomes more sensitive, therefore the action is roughly equal all through the emulsion. It may be objected to this experiment that the developer was at once in contact with the bulk of the latent image in the film-exposed plate, whereas it had to penetrate the gelatin further to reach that in the glass-exposed plate. The authors endeavored to remove this source of error by using a developer so weak and slow in action that the time of development should be very long in proportion to the time required to wet the film throughout: a more rapid developer produced greater differences between the two halves. It might be possible to avoid this objection by stripping the film from the glass-exposed plate, reversing it on to another glass support, and developing it from what was originally the underneath side. An experiment in which a film-exposed plate had a sheet of glass in mechanical contact with it, showed no falling-off in sensitiveness; to impede the escape of bromine, therefore, the impervious surface must be in physical contact with the film.

It is important to observe that this diffusion of the halogen is a process requiring time, and that it is consequently greater as the period of [photographically correct] exposure increases. When the foregoing experiment was repeated under such practical conditions (a weaker source of light) that the exposure rose to 30 seconds, there was scarcely an appreciable difference between the two halves of the plate. This circumstance explains the notable difference in photochemical effect between a continuous and an intermittent exposure of equal length, which has been remarked by Abney and English. During a continuous exposure, the bromine is constantly escaping at a regular speed; during an intermittent one, in each interval of darkness the liberated bromine has an opportunity of recombining with the altered silver compound, and thus it tends partially to reverse the action that has already taken place. Since, however, the speed of reaction between the halogen and the altered compound has a limiting value, any increase in the length of the periods of darkness during a discontinuous exposure will decrease the photo-chemical effect, as those authors have proved; yet it will only decrease that effect to a fixed minimum. Conversely, if the source of light be very powerful, so that the pressure of the halogen set free is high, its speed of diffusion will be raised and less reversal will occur during the intervals. In cases of photographic over exposure, there is no distinguishable difference between a film-exposed and a glass-exposed plate.

Further experiments on these phenomena, which the present authors denominate "photo-chemical" induction, are in progress.—R. Abegg and C. Immerwahr. Monatsh. f. Chem. 1901, 22, 88.—From The Journal of the Society of Chemical Industry.

THE HOSPITALS OF JAPAN.*

JAPAN has few hospitals, only ten. This is certainly a very small number when we consider that the country has a population of forty-five million and several large cities, one as large as Philadelphia, and three with five hundred thousand inhabitants each. It has a few cities with a hundred thousand people and no hospital at all. Tokyo, the capital of the nation, only has two, the Imperial University Hospital and the General Hospital.

The former is the largest and in many respects as good as any institution of the kind I have ever seen. It is as large as all the other hospitals of Japan put together. It is almost entirely maintained by the government. It has eighty resident physicians and six hundred trained nurses. The average number of patients treated there is twenty-two hundred, and in the various outdoor departments many thousand sick people are treated annually. The main building makes no pretensions to architectural beauty; it is a perfectly plain two-story brick and stone structure, a hundred feet wide and four hundred feet long. It is located in the middle of a beautiful park, with its lawns, green terraces, tropical trees and plants, playing fountains and here and there artistically arranged and various shaped, are comfortable looking rests or seats, some in the sun, others in the shade, many grouped around fountains, while some are scattered along little rippling streams. Here landscape gardening has reached the highest state of development.

This building is only used for offices, reception rooms, parlors, library, museum, billiard rooms, drug rooms, and the microscopical department. This microscopical laboratory is the largest and most complete I have ever seen. Here I had the pleasure of meeting the celebrated Dr. Kitasato who was sent, several years ago, to China and India by the Japanese government to investigate the bubonic plague, and who successfully isolated the bacillus of this disease. He is evidently a very scientific man and an accomplished physician.

With the exception of the operating rooms, all the other buildings connected with this institution are one story high, made of wood, and join the rear of the stone building, leading off from it at right angles and parallel with each other. They are four in number and extend back possibly five hundred feet. About every hundred feet they are connected with each other by covered bridges with glass sides. On both sides of all the wooden buildings, there is a narrow veranda which is usually closed by sliding glass doors. All the wooden buildings are painted white, inside as well as outside.

The physicians and nurses wear white uniforms, European in style. With all this perfectly clean and glittering glass, surrounded by so many flowers and shades, with the sun's rays peeping in here and there, it certainly looks beautiful and healthy.

Connected with these buildings, there is one for the physicians, one for the nurses, and one for the servants, a department for lying-in patients, one for contagious diseases, and one for the insane. The architecture of them all is uniform, the distance between them, and the way they are connected, are all identically alike. Several other buildings, used for minor purposes, are scattered about over the park, making a perfect network of houses, all conveniently arranged and magnificently kept.

The surgical department is a large two-story stone structure, plain, but rather handsome. It stands off by itself. It is a comparatively new building, has only been finished about a year. It has several operating rooms and amphitheaters, and can take care of about two hundred surgical cases at a time. Minor cases are usually cared for in the main hospital building.

Surgeons in this country are very conservative, a great deal more so than in America. Patients are slow to consent to be operated on. They have to know that it is their last chance before they will consent. This is not because they are cowards or not as brave as other people are. It is because they have acquired, and to some extent inherited, a prejudice against surgery. This is not peculiar to the Japanese, it is characteristic of all Oriental semi-civilized people where Buddhism exists. Some of its former teachers prejudiced the people against surgical operations. To cause bloodshed except when favored by their god of war was a great wrong. There was no exception to this rule, even in their relations to the lower animals. To a great extent this prejudice is gradually being overcome.

This makes the surgical work of this great hospital rather small when compared with its other departments. It has septic as well as aseptic operating rooms. In the former, they pay very little attention to cleanliness, but in the aseptic operating rooms everything glitters and is in perfect order and is, no doubt, thoroughly aseptic. In and around these operating rooms you can see large and beautifully arranged instrument cabinets filled with every apparatus and appliance known in connection with modern surgery. The most of them are made in Japan, but they import some of them from Germany, England, and a few from America. The wards are overcrowded, and the rooms for single patients are very small, not over ten feet square, and, strange to say, in an institution so modern and so well equipped in so many respects, would furnish their first-class rooms, just as they are in a hotel, with velvet carpets, rugs, curtains, cloth-covered sofas and chairs.

The crowding of their wards to overflowing seemed to me cruel, yet the patients looked comfortable, and many of them happy. Both sexes were often in the same wards, being bathed and dressed at the same time, without any embarrassment to any one.

It has been said that nudeness can be seen in Japan more than any other place in the world, but it is never looked at. The correctness of this was impressed upon me when going through the wards of this hospital.

While the surgeons in this country are very conservative, they are not timid. Many of them do excellent work. I spent a day in this Imperial University Hospital, saw several operations, and I observed nothing that was not intelligently and skillfully done. One young assistant surgeon, who could speak a little English, told me that he had used the Murphy button seventeen times without a single failure, and that the chief surgeon had performed seven laparotomies for perforation in typhoid fever and had saved three cases.

I was astonished to see so many cases of tuberculosis in this hospital. Forty per cent of the inmates had tuberculosis. Going back over the records for five years shows that thirty-five per cent of all cases admitted were tuberculous. This great susceptibility to tuberculosis, on the part of the Japanese, was something new to me. Statistics show that thirty-two per cent of all deaths in Japan are due to tuberculosis. In America it is less than fifteen per cent and we are justly alarmed.

Rheumatism was the next most prevalent disease I found in this hospital, and skin diseases were very rare.

It is easy to observe the causes of consumption in this country. Leaving out all hereditary tendencies, the habits and customs of the people would naturally cause it to develop. Their houses are always built on the ground, uniformly one story high, few windows and they are like pigeon-holes. They have few facilities for heating their houses. Even in the coldest weather they will do without fire, consequently their homes are cold, damp and dark, just the conditions and surroundings to favor the development of tuberculosis. Besides a Japanese seldom has anything on his floor. Sometimes among the better classes they

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will use a straw matting, something like we use in the summer. They always take off their sandals or wooden shoes at the door and wear nothing on their feet while in the house, no matter how cold and damp it is. With these conditions and methods of living it is not surprising that consumption and rheumatism are so prevalent.

The absence of skin diseases among the Japanese is evidently due to their cleanliness. I suppose they bathe more than any other people in the world. There are over eleven thousand public baths in Tokyo alone, and it is stated that four hundred thousand people patronize these baths daily. They heat the water a great deal hotter than we do in America, seldom under 110 deg. F. and often 118 or 120 deg. F., and remain in the bath for hours, especially in the winter, as it is a cheap way to keep warm. It costs them one sen for each bath, about a half cent in American money.

I noticed in the Imperial University Hospital that they were giving creosote in pulmonary tuberculosis, in seventy-five-drop doses, three times a day, injecting serums made in Germany, and experimenting with some made by themselves. They were using inhalers and sprays just as we do, and I suppose with about the same success.

The General Hospital at Tokyo is quite a nice institution. It is partly under the control of the Red Cross Society of Japan. It has twenty resident physicians and two hundred trained nurses. Its average attendance is seven hundred, besides thousands of sick people are treated in its various outdoor departments. The buildings are old and the grounds have an appearance of dampness and neglect, a lack of brightness that does not very favorably impress a visitor. The general arrangements of the buildings are on the cottage plan, with one very large brick building which is used for the officials of the hospital. The operating rooms are fairly well arranged and equipped. They will compare very favorably with some of our large hospitals.

The Yokohama Hospital is small and badly arranged, and evidently poorly managed. It is attended by a staff of three physicians, who live in the city. The building is old, damp and dark, surrounded by no gardens or yard.

Kioto, the old capital of Japan, a city of six hundred thousand population, only has one good hospital. This is the Kioto Hospital Medical School. It is a hospital and medical college combined. They are under one management and the buildings are connected. The grounds cover ten acres and are beautiful. The buildings cover about three acres and all but one of them are made of wood, and are two stories high. The main building is three stories high, built of stone, and it is new and a handsome structure. Twenty-eight physicians are connected with this school and hospital. Twenty-one students were graduated last March. All the physicians live in little cottages on the hospital grounds, and the students room in the main building. Three physicians from Germany and one from Holland teach in the medical department. It is partly supported by the city government.

About five years ago all of its buildings were destroyed by fire, and they have only in the last year finished rebuilding them, consequently everything is new and up to date. They have two operating rooms not connected with amphitheater halls. I have never seen anywhere two operating rooms more conveniently arranged or more thoroughly equipped. Here pharmacy is taught as well as medicine.

Several years ago the medical school was divided into a medical school proper and a preparatory medical school. When a student begins with the preparatory studies it takes him twelve years to graduate. This hospital has the most complete hydrotherapeutic establishment of any in Japan. It occupies the basement of the main building and is thoroughly modern in every respect. It comprises a Turkish bath, vapor bath, Charcot's douche, electric baths, sulphur baths, iron baths, and a suite of hot and cold baths with sprays. Annexed to this department is a completely fitted medical gymnasium.

The Doshesha Hospital at Kioto is kept up by a Canadian mission. It has no resident physician and only one trained nurse, who is from New York. Three physicians attend the hospital, each a week at a time, in rotation. They have six or eight beds fixed up especially for foreigners, and many Europeans and Americans have been cared for there.

Nagoya, a city of two hundred thousand population, has only one small hospital. It is a private institution, run by three rather bright, enterprising young Japanese physicians. The buildings were not originally constructed for the purpose for which they are now used. The grounds are small, no lawns, and few shades. The surroundings had a dilapidated, neglected look, and the inside was dark, damp and had a mouldy smell. Their little operating room looked neat, but was poorly furnished. They had sixteen patients, but none of them were surgical cases.

Osaka has a city hospital. I did not have an opportunity to visit it.

Kobe and Nagasaki each has a hospital. The one at Kobe interested me greatly. Its buildings are very large and it is evidently well patronized. They have eighty trained nurses, and an average of two hundred and fifty patients. Its reception rooms for outdoor patients were crowded to overflowing. The general operating room for third-class patients interested me more than anything surgical I have seen in Japan. Here seven operations in one room were being performed at one time. It reminded me of Barnum's circus, it had so many attractions going on at one time. It had no preparatory ante-room for undressing or dressing. The anesthetic was administered, and, in fact, everything connected with each case was done in this one room. Female as well as male patients were admitted and treated or operated on as their time came I noticed one surgeon was operating for urethral stricture in the male, another setting a broken arm for a little boy, while another was doing gynecological work. Only seven physicians remain in the hospital at night, all the others live in different parts of the city. I could not learn how many were connected with it or how they were appointed.

The Red Cross Society has recently established a hospital in Kobe. The day I visited it, it only had three patients, one nurse, and no resident physician. I did not see the hospital at Nagasaki. I understand it is used partly for the Japanese navy. America, England and Germany all have naval hospitals at Yokohama.

I suppose it might be said that there are a great many other hospitals in Japan that I have not mentioned. There are many little mission hospitals where they are doing dispensary work, and often they have a few beds where they take care of three or four patients at a time. A great many physicians have their own little private hospitals. I visited several of them. They are so small, have so few facilities, and are so poorly patronized that they are not recognized by the local city directories. The Japanese army has several hospitals. I did not, of course, visit them.

The Imperial Hospital at Tokyo, that I described at first, seems to be the medical center of Japan. Nearly all the best people throughout the country when they have to submit to any important surgical operation, or have any serious complicated disease, go there. The distance from any part of Japan to Tokyo is short, the railroad facilities are good and the fare is less than a cent a mile. This makes the surgeons, physicians and specialists there very accessible, and they are patronized more than they are in any other part of the country.

The Japanese physician is peculiarly fitted for certain departments of medicine. One characteristic of the best element of them is to be industrious, deliberate, careful. He loves more than anything else to spend days, weeks, and even months, at some little thing. Mr. East certainly knew the people well when he tersely said that they seemed to be "great in small things and small in great things." I notice that they are enthusiastic workers in microscopy, their patience seems never to tire; they will prepare slide after slide, specimen after specimen, and their interest never sags. This kind of work suits them.

In surgery the smaller and more delicate and difficult the operation is, the more it interests them. The average Japanese physician would rather see a cataract operation than a hysterectomy. To watch them prepare for an operation, the time they seemingly throw away arranging little things, the minute instructions they give their assistants and nurses, even in minor surgical cases, and to observe them fix, with so much care and deliberation, every table and tray, every knife and sponge, perfectly oblivious to time, is as amusing as it is tiresome to the hustling, restless, and impatient American.

TEAK INDUSTRY OF SIAM.

ONE of the principal industries of Siam is the teak-lumber business, says Consul-General Hamilton King, of Bangkok. Teak is the most valuable lumber for shipbuilding in the world. It does not yield to the influences of moisture and drought; it is not liable to the attack of borers and other insects; it does not split or sprawl; and, while it is a strong, durable wood, it is easy to work and very light in the water. As a beautiful, dark-colored wood susceptible of a very high degree of finish, it will continue to be in demand wherever fine finishing lumber is needed in shipbuilding, and because of its peculiar qualities that resist the influences of iron when brought in close contact therewith, there is no substitute for it yet discovered as the backing for armor plates in vessels of war.

Because of the attention given at this time to our navy and merchant marine, information on this subject should be of interest in the United States.

The area of the earth's surface in which valuable teak forests are found is not extensive, being restricted to Burma, Siam, and Cochin China. Some teak has been found in Java, but it is not of a superior quality, and as yet the forests of Cochin China and a part of Siam are inaccessible. The limit of their area and the increasing demands now made upon these forests, because of the rapid growth of shipping throughout the world, is presenting a problem which the British government has attempted to solve by planting new forests; but many of these attempts have proved failures, and at best it takes from sixty to eighty years to grow a tree large enough for superior lumber.

There are but three ports in the world from which teak is exported—Rangoon, Moulmein, and Bangkok. Of these, Rangoon stands first and Bangkok and Moulmein rank about equal in the amount exported by each.

The term "teak forest" is a misnomer, for the teak trees do not form a forest as the term is understood in America, but generally are rather found in clumps, or perchance as individual trees, in forests and jungle among other timber. This wood grows upon the mountain sides and in high, broken country, and is segregated to the extent of one tree for every ten or one hundred trees of other kinds throughout the forest in which it is found. It is much more expensive to work such timber out to the streams than it is to work the forests of America, where the trees grow nearer together and roads are constructed by which the entire product can be removed.

It is this heavy timber thus scattered that renders the use of the elephant in the teak forests imperative, for teams of any kind would be prevented from doing the work by the dense jungle. This great beast, accustomed to make his way through the undergrowth, is strong enough alone to handle the logs and work them to the stream. But elephants are expensive and at the same time are singularly delicate animals. On an average, an elephant will work only five hours a day five days in the week and seven months in the year. And even at this, he must be handled with the greatest care, and the owner is fortunate who escapes with not more than five per cent loss per annum by death.

Siam furnishes about one-fourth of the teak of the world, and the quality of the teak timber found here probably ranges with the best. It is customary for trade reports to rate it second to Burmese teak; but all these reports come from British sources, and the British control the teak interests of Burma. The British Admiralty contracts have for many years been placed in Burma, and that department is proverbially slow in accepting a change; again, greater experience there may have resulted in greater care in manufacturing the product for the market. Be that as it may, the streams that bear the Burmese and the Siamese teak to the seas pierce the same regions and find their product in the same forests.

The teak forests of Siam are situated in the upper provinces at a distance of several hundreds of miles from the capital, Bangkok, with which they are brought into communication by the River "Chow Phya," commonly called the Menam, and its tributaries. In these forests, which are leased for terms of years to the upcountry traders, the trees are first "girdled"—that is to say, at the proper season of the year the bark and sap are cut through all round the trunk close to the ground, in order to make the wood lighter and better for land and water transport before it is carried away, and to prevent what is known in America as sap rot. This is rendered unnecessary in countries where the cold of winter drives the sap out of the trees and thus prepares them for the lumberman through nature's own process. This operation must be completed at least two years before the trees are cut. The trees are then felled at the proper time and made ready for transport. They are afterward hauled by means of elephants to the creek or small stream which is nearest to them. These several operations—girdling, felling, and transporting to the creek—require a period of about three or four years; but it is after the butts reach the creek side that the most formidable causes of delay begin to operate. Even if the season should be favorable and the brooks full of water, the logs float at a slow pace down them, and have to be worked forward with the aid of elephants by the process called "ounging" until they reach the larger streams. Here, their progress is impeded by blocks and obstacles of all kinds, and the assistance of elephants is still needed. The transport of a number of logs, after arriving at the larger streams, to the rapids—about 150 miles—requires on an average four months (in a good season), and thence downward to Bangkok, seven to ten weeks. Under the most favorable circumstances they may reach Bangkok in six months from the time of arriving at the main streams, or three and a half years from the time of being girdled in the forest.

Unfortunately, it is by no means in every year that there is enough water in the creeks to float the logs at all, and still less certain is it that they will be floated as far as the deep stream before the floods subside. Out of ten years, there will not usually be more than two or three when there are full floods, and three or four when there are floods of average height and duration. The other three or four or even five years will be "dry" years, and will only permit of a very small quantity of wood being brought out of the forests.

Thus, taking one thing with another and allowing for the average delay caused by more or less dry seasons, it appears that from the time when money begins to be expended upon a teak tree until it arrives in Bangkok and can be exported, a period of from three and one-half to seven years, or even more, must elapse, during the whole of which money continues to be expended on the tree, either in working it or watching it, while no returns can be had. Besides the actual expenses of felling and transporting by land and by water, there is the royalty to be paid to the lessor of the forest and the government royalties payable on the main river. It is also necessary to keep a considerable staff of watchers to guard against the continual pilfering of logs and against fires.

From the foregoing, it will be easily conjectured that a very large capital is needed for persons engaging in the upcountry teak trade, and the capitalists who embark in this business must be content to see their money locked up for a very long time before profits can come in. If a bad year—i. e., a dry season—should occur, no profit can, for the time being, be expected; and if this should be followed by a second bad season, it will be impossible either to make any profit or even to pay the interest on the capital expended. Hence it happens that in contracting loans in this business and making arrangements with the lessees of forests, a long period of years is included in the compact, so as to allow of the very gradual repayment of the sums advanced. In many cases, no interest is paid upon such loans for several years, while the wood is being worked down to Bangkok, and then, out of the ultimate proceeds of sale, are paid at length arrears of interest which reach sometimes an almost incredibly large sum. If a season is good, the trader pays the interest readily and willingly; if it is bad, he is obliged to hold it over, much against his will, for the rate of interest is heavy in Siam, and, in the case of many traders who are "men of straw," exorbitant.

As it is with the lessees and head contractors, so it is with the subcontractors and foresters. These latter invariably obtain advances from the lessees and repay them in kind, with interest in good seasons. It is an unheard-of thing for these people to pay interest in money; and a lessee who attempted to enforce such payment would not only fail to obtain it, but also forfeit his chance of obtaining contractors in the future. On the contrary, when the interest on loans to subcontractors is unpaid, owing to dry seasons, it is necessary to advance them fresh capital, in order that they may be able in a better year to deliver the wood which they owe.

The logs when felled, and before being transported, are stamped with the owner's hammer mark. Having reached the creeks, and having been floated down river past the rapids, they are made up into rafts, which are dispatched en route to Bangkok in charge of raftsmen who understand the business and generally work for a single employer, between whom and themselves there is mutual confidence. The task of these men, as well as of those who work the logs down to the making-up stations, is one of great responsibility. They have to contend with the great difficulties of navigation and to guard against the machinations of the timber thieves who infest the water courses. Oc-

casionally, notwithstanding the utmost vigilance, a raft will break up; and then an immense amount of energy is required to collect the logs and save them from plunder. One of the most important advantages of an upcountry teak trader is that of being always able to command the services of able and trustworthy rafters, and one of the most serious injuries which anyone can inflict upon a lessee is to destroy or impair the confidence of the rafters in his credit and prospects.

The teak trader must also find and keep reliable and well-paid agents at the principal towns on the river where the rafts are made up, and at the station where the duties are levied. He must, during his visits to Bangkok and to places within his district, intrust his valuable elephants and other movable property to the charge of employes who, if not punctually paid, are apt to levant with the animals or other things and sell them at more or less ridiculous prices for their own benefit.

In short, the teak trader of the forest must have at his command a very large reserve of capital, to be employed during bad years in keeping up the huge staff which is absolutely necessary for successfully carrying on his business.

The cost of working teak in Siam has been greatly enhanced during the last ten years. The royalties to the government have increased 200 per cent, the price of elephants has increased over 100 per cent, and the cost of labor to work the forests has advanced over 200 per cent; and to this increase has been further added a heavy difference in exchange, which works to the disadvantage of the producer.

The limited area of the forests from which the supply for the future must come, the restrictive measures now being imposed by the government on those working concessions already granted and the refusal to grant new concessions, and the increasing demand year by year, together with the above-mentioned advance in cost of production, argue a material rise in the prices of teak in the near future. Notwithstanding all this, prices are ranging comparatively low just now, because of large purchases having been made in anticipation of this expected advance, and because the past season has been phenomenally favorable for bringing teak down to the market.

Again, the teak market of the future promises to be more steady than it has been in the past, because of the elimination of the small traders from the business. There were many of these in the earlier days, but they have been gradually crowded out by the circumstances already mentioned in this report. These small traders, being unable to hold their product for any length of time, were obliged to sell when their rafts came to the local market for whatever prices they could realize; and on account of the large number of these men in the trade, this often caused a decided fluctuation in the market.

Beyond the head waters of the Menam, in northern Siam, and on the other side of the divide which forms the water head that separates the waters of the Menam and the Mekong Rivers, are large tracts of virgin teak forests of splendid quality. The Mekong penetrates this region 2,500 miles from its mouth; but its rapids and water falls render rafting impossible and must prove destructive to individual logs in their journey to the sea. Thus shut off from approach from the north and inaccessible from the south because of the mountain range, these valuable forests will probably remain undeveloped for years to come—buried treasure for the future of Siam.

FIG. 1.—BOLIDE GASOLINE RACING CARRIAGE.

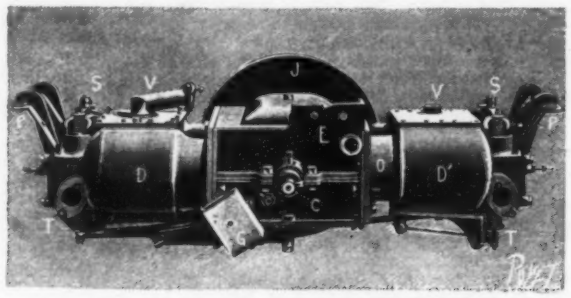


FIG. 3.—FOUR-CYLINDER, 50 H. P. BOLIDE AUTOMOBILE MOTOR.

THE FASTEST GASOLINE AUTOMOBILE.

IF we are to believe the reports that are emanating from the works of our large manufacturers of automobiles, the important races of this summer will be run with motors of from 50 to 70 H. P. The speed obtained (if the carriages reach the goal without serious damage, and if the tires do not, as frequently happens, melt at such fantastic velocities) will far exceed that of the swiftest express trains, since it will reach, it is hoped, nearly 74 miles an hour at moments.

Our readers will perhaps be interested to know some of the details of one of these high-speed automobiles. In order to avoid any appearance of partiality, we shall select the gasoline carriage that now holds the record for speed and which will this year be put to the severest tests. This vehicle was constructed by M. Leon Lefebvre, manager of the Bolide Society. On the 17th of June, 1900, it covered 0.62 of a mile in 38 1-5 seconds, at Dieghem, near Brussels, say at a speed of more than 58 miles an hour. The same carriage, driven by M. Jenatzy, at the Salon race of July 1, covered 62.1 miles in 1h. 20m., and 1.24 miles in 68 seconds, which would be at a rate of 65.82 miles an hour.

The four-cylinder gasoline motor, of the usual four-cycle type, was of 30 H. P. Without any modification in its bore, which is 5.9 inches, or in the piston stroke, which is 3.93 inches; and without any change in the number of revolutions, which varies between 110 and 900, according to the opening of the throttle and the lead of the spark, it now gives 50 H. P. in consequence of the increase of compression, which has been changed from 49.78 to 71.11 pounds per square inch. In running order, the carriage, with its tanks containing 26.42 gallons of gasoline and 13.21 gallons of water, weighs 2,755.75 pounds. Its tread is 4.75 feet, and the reach between front and rear axles 6.98 feet. The height of the front wheels is 3.6 feet, and that of the hind ones 5.9. The section of the tires is respectively 3.54 and 4.72 inches.

The carriage has three speeds of 18.63, 37.26 and 55.89 miles an hour at the normal rate of 700 revolutions per minute of the motor—a rate that may be raised to 900 by a variation in the sparking. As is well known, it is only necessary to mount larger sprockets upon the chain shaft of an automobile of the usual type in order to obtain greater speeds, at the necessary expense, however, of what may be called its ascensional power. The carriage runs faster upon a level, but climbs hills less easily, since no instrument can escape the inexorable laws of work. An able manufacturer, then, should proportion the diameter of such sprockets to the power of the motor and to the mean profile of the roads over which the vehicle is destined to travel.

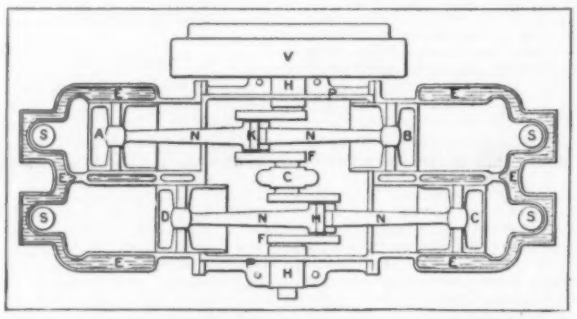


FIG. 4.—DIAGRAM OF PARTS OF BOLIDE MOTOR.

A, B, C, D, pistons; *E*, water jacket; *F, F*, cranks; *G*, center bearing; *H, H*, end bearings; *N*, connecting rods; *P*, frame; *S*, valves; *V*, flywheel.

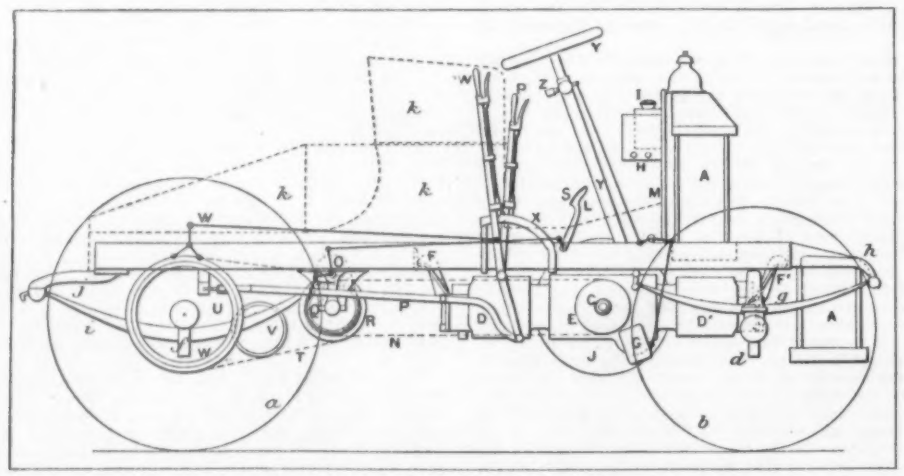


FIG. 2.—ELEVATION OF BOLIDE RACER, SHOWING PARTS.

A, A, flanged radiators; *C*, motor shaft; *D D'*, cylinders; *E*, frame of motor; *F, F'*, brackets for suspending motor; *I*, multiple oiler; *J*, flywheel containing friction clutch; *L*, pedal for operating clutch; *M*, dash; *N*, sprockets and chain from motor to countershaft; *O*, box containing change speed gears; *P*, lever for operating gears; *R*, band brake on differential; *S*, brake pedal; *T*, chains from countershaft to rear wheels; *U*, chain tightener; *V*, muffler; *W*, brake on rear wheels; *X*, notched sector for levers; *Y* steering wheel; *Z*, throttle and sparking handles; *a*, driving wheels; *b*, steering wheels; *d, f*, axles; *e*, steering heads; *g, i*, springs; *h, j*, spring suspension; *k*, body.

The motor, with its flywheel, weighs 650 pounds. Each of the four horizontal cylinders works as follows: The first draws in its charge while the second is compressing; the piston of the third is driven back by the explosion, while that of the fourth expels the burned gases. The sparking is done by a battery of two accumulators, which is placed under the seat and which sends its current successively into one of the four induction coils inclosed in a box hooked to the dashboard of the carriage, and which consequently produce in each of them a secondary current of high tension, the breaking of which gives alternately in the cylinders the spark necessary for the ignition of the gas.

The total consumption is about 5.28 gallons of gasoline an hour. This may be reduced to 2 gallons, when relatively low speeds are employed and the admission is consequently almost completely closed. The throttling of the motor as well as the variation in the moment of sparking with respect to the position of the piston in the cylinder, is effected by means of handles that are always within reach of the driver and placed upon the oblique steering post.

Upon an inspection of the accompanying figure, from La Nature, it will be seen that the opposed cylinders are not offset, with separate cranks for the two connecting rods, but they are in line with each other, while the connecting rods have a common crank. Such a construction permits of obtaining for each rod extremity as wide a range as possible, and at the same time a better equilibrium of the parts in motion.

The cooling is effected without a pump through the conversion into steam of the water that surrounds the cylinders and the condensation thereof in the flanged radiator that surmounts them. A second radiator situated beneath retards such conversion into steam by keeping the water at a lower temperature than that of ebullition. The cooling takes place so much the better in proportion as the air circulates more speedily between the flanges, or, in other words, in proportion as the carriage runs more rapidly.

The control of the hind wheels by the motor is effected by a succession of parts that are operatively connected with a friction clutch pressed by a strong spring in the flywheel of the motor, and which the driver can at will push back by means of a pedal in order to throw the mechanism out of gear. A chain connects the motor shaft with the speed-changing shaft. Upon this latter the displacements of the gears

controlled by the driver bring about in turn four changes that give the three forward speeds and the reverse. Two lateral chains transmit motion from the countershaft to the wheels according to the usual method.

The hand and foot brakes, which are very powerful, operate in both directions. One of them acts upon the drum that contains the differential and the other upon rings mounted on the wheels.

Steering is accomplished by means of a hand wheel mounted on an inclined post which carries at its lower part a bevel gear meshing with a sector operatively connected with the coupling bar of the front wheels. The slightest motion of the driver's hand has, therefore, the effect of varying the inclination of the steering gear without the lateral shocks that the wheels may receive doing any harm. The steering is therefore precise and slightly reversible.

The simplicity of this vehicle is certainly one of its most notable features and one of the best guarantees of its success. Simplicity implies lightness, and lightness almost always implies strength, in road locomotion a very necessary adjunct, for their terrible momentum condemns to breakage the heavy vehicles that have the pretension "of consuming space."

LOW GRADE GOLD MINING AND MILLING.

GOLD mining no longer bears the characteristics of the game of chance. I do not pretend to say that risks are no longer to be taken; but I do mean that perseverance, energy, and above all, a liberal supply of common sense, will reap their rewards in mining quite as surely as do these qualities in the management of any other successful enterprise. "Hard luck" has ceased to be the wail of the mine manager. Eternal vigilance for waste and inefficiency generally turns the scale in the dividend's favor—granting, of course, that there is something more substantial to start with than the average "stock deal."

The saving of the ore values is not now the wasteful operation of a few years ago. Of course the process of amalgamation still plays an important part in mining operations; but this method *by itself* will never make a satisfactory saving on the average big bodies of low grade ore which are finding favor with mining investors. To-day not only gold and silver, but any accompanying lead, copper, or zinc, in paying quantities, are saved in the mill.

At first thought it may appear strange that the average low grade vein of mineral is quite as much in demand as the one which gives larger values. However, when one studies the economy of mining, the reason is plain. Thrown up by volcanic action through a comparatively wide rent in the earth's surface, the low grade vein is fairly continuous. The high grade vein, on the other hand, has generally filled some convenient, narrow, uncertain crevice; and though its values are likely to be concentrated, there is no assurance that the values will persist. The narrowness of the vein also necessitates the removal of the wall, or country rock, with the ore. This drawback must be overcome by sorting—and sorting, like every additional operation in mining, costs money. In the low grade property, on the contrary, only ore is mined; and, except in cases of accompanying streaks rich enough to ship direct, the whole product is put through the concentrating mill.

The history of the process of concentration is one in which necessity has been the mother of invention. Properties which ten years ago would have prospered but for the fact that the margin of profit was eaten up by the railroad and the smelter, are to-day paying handsome dividends. Or, rich mines, once abounding in free-milling ore near the surface, have run into refractory ore with depth, thus requiring expensive smelting plants of their own or the payment of freight charges for worthless quartz and gangue rock shipped to a commercial smelter at some distant point. These difficulties have been overcome through the use of modern concentrating machinery.

To illustrate: Let us suppose that some years ago a certain prospector was endeavoring to interest a party of Eastern capitalists in a claim which he had staked. Suppose, further, that his ground covered the course of a vein for fifteen hundred feet, and that the ore, averaging fifteen feet across, "ran" twenty-four one-hundredths ounces in gold and six ounces in silver; that is, approximately $8.50 to the ton. He was well aware that fifty tons of such ore shipped to a smelter would not begin to pay expenses. However, he induced the capitalists to send an expert to examine the claim. The expert, of course, turned the proposition down. The prospector insisted that a little development would disclose richer ore, but the men of wealth wisely decided that the price was altogether too fancy for a mere "hole in the ground."

The years roll by and the capitalists have forgotten the prospector and his $8.50 vein. One day, however, he turns up and tells the marvelous story of a mine near his own which produces even a lower grade of ore. This mine, he says, is making the fortunes of five or six men who dared to be progressive.

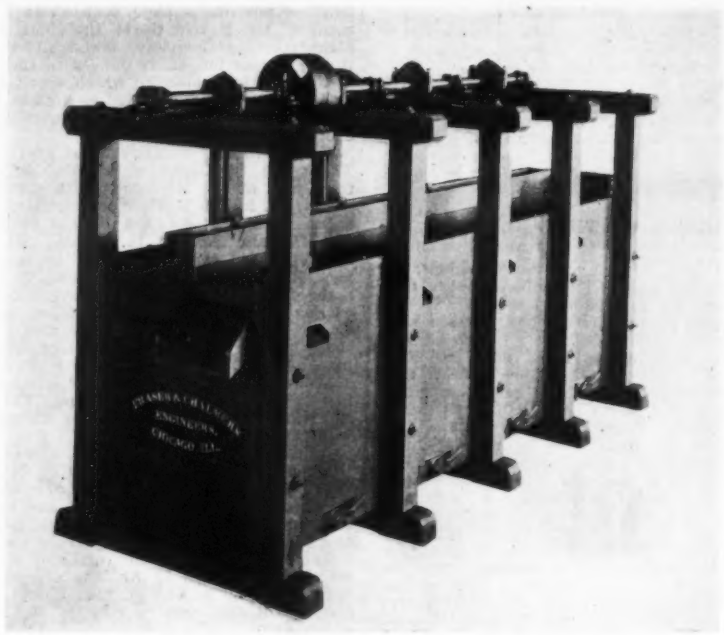
"Please explain," say the incredulous capitalists.

"Very simple," answers the prospector. "Suppose that several years ago I had mined fifty tons, or five car loads (narrow-gage) of my ore. That represents a gross value, at $8.50 a ton, of $425. The freight would have amounted to $2 a ton. To this add $2 a car for switching and $9.50 a ton for treatment. In all we have $585. Disregarding the cost of mining and tramming, I would have lost just $160.

"Now, my neighbors, as I have said, are making a profit on ore which carries even lower values than mine. They are operating machines which get the better of the railroad and the smelter. The iron pyrites which carries the greater part of the gold values is separated from the quartz; and this operation is so perfect that the value of five tons is concentrated into one.

"Leaving out of consideration any free gold saved upon the copper plates of the battery, and granting that the smelting charges are the same as for crude ore (which figures, by reason of excess iron, are likely to be less), the result of a fifty-ton shipment would be summed up as follows:

Value of ore in form of concentrates, 10 tons, or 1 car		$425.00
Freight, at $2 a ton	$20.00	
Switching 1 car	2.00	
Treatment at smelter, at $9.50 a ton	95.00	
Mining and milling 50 tons crude ore, at $2	100.00	
	$217.00	$425.00
Profit for the car	**$208.00**	



EXTERIOR VIEW OF JIG.

The capitalists investigate further and, finding the facts as represented, purchase the claim.

The principle of concentration is crudely shown in placer sluicing—an operation in which the gold, by virtue of its high specific weight, is deposited in a stream of water and the gravel carried away. This method, it should be noted, was designed primarily to save the metal in the free state. Modern mills, however, save not only a large per cent of free gold, but any other metals which may or may not carry gold in association.

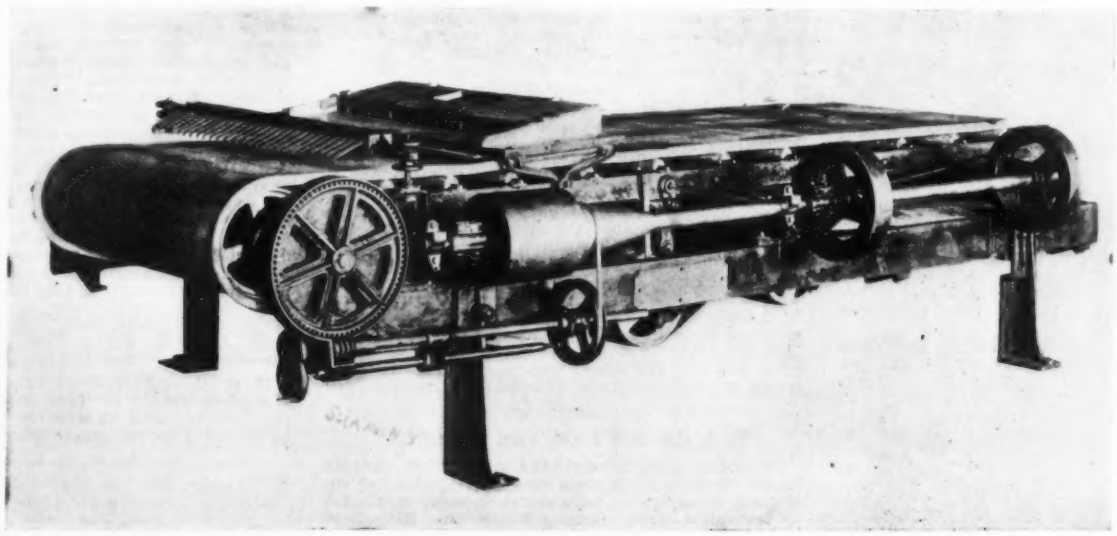
The methods of concentration vary according to the character of the ore. The operation which I shall briefly describe represents the practice of one of the leading mills in the San Juan region of Southwestern Colorado.

The ore, after it leaves the mine, is sorted (if necessary) and the lower grade delivered to the storage bins of the mill, whence it is fed into the jaws of a powerful crusher, which reduces it to about the grade of nut coal. Proceeding through a chute it passes between two rapidly revolving cast-iron rolls, which still further reduce the grade to that of ordinary bituminous slack.

In order that the succeeding machines may do their best work, the ore at this stage must be graduated. This operation is known as sizing, and is accomplished by a set of four revolving cylindrical screens slightly inclined from the horizontal to allow the unscreened portions to pass out at the lower end. These screens vary in mesh from three-eighths to one-tenth of an inch.

The product from the rolls is delivered into screen No. 1—that is, the coarsest. That which fails to pass through the mesh emerges at the lower opening, falls through a chute to a second set of rolls for recrushing, while the screened portion proceeds to screen No. 2. No. 2's unscreened remainder descends to a separating machine called the jig, and the screened particles are delivered to the following screen. This operation is continued until four screens and three jigs have been called into service. The fine, unscreened residue from the last screen passes to one of a series of machines called the frue vanner.

The jig mentioned above usually consists of a wooden box about 6 feet high, 8 feet long, 4 feet wide, and divided into three or four compartments. One of the latter is represented by the accompanying sketch.



A FRUE-VANNER CONCENTRATOR.

A is a tight-fitting plunger actuated by the eccentric *C*. *B* is a screen with mesh corresponding to that of the revolving screen which delivers the ore. The box is filled with water and the ore bedded over the screen *B*. As the plunger descends the water is forced upward through the ore. Thus the quartz, which is

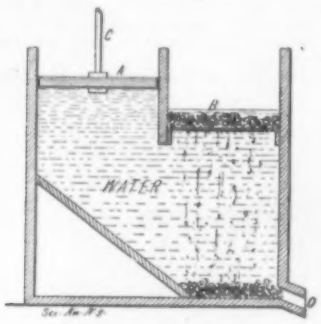


DIAGRAM OF THE JIG.

lighter than the lead, copper or iron sulphides, or whatever the mineral may be, is forced to the top. The suction caused by the piston's ascent draws the mineral through the screen into the box, whence it is removed through the outlet *O*.

It is safe to say that the jig, if its work has been efficient, has saved 75 per cent of the ore values. The product is almost entirely free from quartz or other gangue. The remaining 25 per cent is to be found in the unscreened residue from No. 4 screen and the refuse quartz from the jigs. The jig residue must be crushed to a fine pulp under stamps weighing 750 pounds, and dropping at the rate of 90 times to the minute. This pulp, carried in a stream of water, is forced out from the stamp boxes through a fine meshed screen and over a copper plate carefully coated with mercury. The latter forms an amalgam with any free gold which may be present. The remaining slimy water is then allowed to flow to machines called hydraulic sizers, which grade the finely-suspended particles. Space will not permit a description of the several varieties of this machine. Suffice it to say that the action of gravity accomplishes the result.

A few words now regarding the Frue vanner—probably the most popular machine on the market for the abstraction of mineral from the pulp-bearing water after it leaves the copper plate. It is about 14 feet long, 6 feet wide, and consists essentially of a rough surfaced belt which is carried on rollers as represented in the sketch:

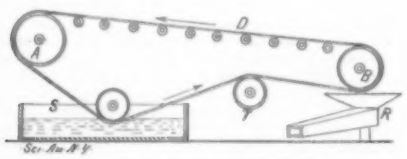


DIAGRAM OF THE FRUE-VANNER CONCENTRATOR.

Roller *A* is slightly higher than *B*. *D* is the belt traveling in the direction of the arrows and kept at the proper tension by means of the tightener *T*. The belt is provided with flanges to prevent the water from flowing off at the sides. *S* represents a settling tank partly filled with water, and into which the mineral is carried by the belt. *R* is the outlet for the waste slimes.

When the machine has been properly adjusted the operation is comparatively simple. The stream of water bearing the pulp already sized for this particular vanner flows over the surface of the belt. An additional stream of clear water washes the light quartz particles downward and leaves the heavy mineral to be carried over into the settling tank. In order that the ore may be kept in a state of agitation, the belt is provided with a lateral shaking motion.

The vanner has several modifications, namely, the Wilfley, Sweet, Cammett and Bartlett patterns, which discard the belt for a broad, inclined table provided with wooden riffles and a double shaking motion. The new Hooper patent involves the principle of *dry* concentration, and is said by many to effect the closest saving.

If the machinery has thus far done its work well, the saving should approach very close to, and perhaps exceed, 90 per cent of the assay value. But any one of a thousand obstacles may render this result impossible. The water fed to the vanners may be too cold, the gearing may lack proper adjustment, the inclination of the vanner belt may be too great or too little, the ore may be too finely crushed, or the sizing imperfect. When every precaution has been taken and the loss persists, it may be well to install a set of sliming tables below the vanners. These are long, inclined surfaces of canvas, which catch the mineral in their meshes as the slimes pass over.

The foregoing gives an idea, in brief, of the process of concentration. The art is yet young, but brains and skill are certainly hastening the time when the saving will approximate 100 per cent. As it is, the results are wonderful. A large body of ore assaying $5 to the ton, and susceptible of a 5-to-1 concentration, should, with plenty of water, the proper machinery, and, above all, good management, pay handsomely. In certain favored regions $2 ore has been known to yield a profit. These facts certainly indicate that gold mining is not necessarily a game of chance.

Perspiration Stains.—These spots are removed from white or colored fabrics by washing with a solution of hyposulphurous acid and next with water.

THE LEAD AND SILVER MINES OF NEWBURY.

By HORACE C. HOVEY.

QUARRYMEN, while blasting rock for the State highway, recently opened a vein of argentiferous ore, which the writer was requested to examine. The quarry is on land owned by Mr. Walter C. Greeley, in Newbury, Mass., about a mile from the city line of Newburyport. The vein, as far as opened, is about ten inches wide and eight feet long, and may prove to be only a pocket. Most of the ore in sight has been taken away, and it is yet to be found what may be developed by deeper excavation. Thus far the find has interest only as showing a new location of ore. Selected specimens have been assayed with varying results. Mr. Martin Boyle, the chemist of the Towle Manufacturing Company, found silver in the galena in the proportion of 42 ounces to the ton; while an assay office in Boston, to which specimens were taken by Mr. Rufus Read, reported as high as 75 ounces. But it must be remarked that these were assays of small, choice pieces of the best ore.

The above find reminds us of previous discoveries. There are traditions of colonial excavations along the banks of the Merrimac, with sufficient results to enable Mr. Joseph Moulton to manufacture a few silver spoons. In 1868 Edward Rogers found float ore in the Highland Pasture, in Byfield. He and Albert F. Adams traced these fragments to land belonging to Mrs. Richard Jaques, from whom they bought eight acres for $350. After six tons of galena had been extracted the property was bonded to Chipman and Kelley, in August, 1874, for the sum of $100,000, and these parties at once began active operations. Chipman afterward sold out to the Hon. E. P. Shaw. A second mine was opened on the adjoining lot, belonging to the Hon. Moody Boynton. The Chipman and Boynton mines were united by tunnels, and shafts were sunk to the depth of 170 feet. Consolidation took place, and a stock company was formed under the name of the Merrimac Mining Company. Three-quarters of a mile nearer Newburyport the Lawrence Company opened a third mine; and not far from it, on land owned by Robert Smith, the Bartlett Company opened a fourth mine. These four mines were along a line coinciding with the strike of the country rock, which is about N., 75 E. The dip of the veins was vertical for 30 or 40 feet, then inclining S. E.; while the dip of the country rock is N., 30 W. Besides galena, pyrites and quartz, the lodes yielded siderite, limonite, hematite, tetrahedrite, malachite, azurite, etc. The ore yielded from $150 to $250 worth of metal to the ton.

The excitement became intense and speculation was rife. Prospecting went on in all parts of Newbury, Newburyport, Boxford, Salisbury, Georgetown, and other parts of Essex County. Barren hills and arid pasture lands were in the market at fabulous prices. The climax was reached on that gala day, June 2, 1875, when Newburyport was decked as for a Fourth of July celebration; a cavalcade with a brass band headed a long procession that escorted a train of wagons loaded with 160 tons of argentiferous ore, which was finally taken on board the schooner Nadab and transported to New York city.

The mining continued for about six years, with waning results as the costs increased and the profits diminished, until in 1880 operations were practically abandoned, though it is possible that they might have been continued with more modern methods of working. Public interest has again been temporarily revived by the recent discovery already mentioned; but the conviction seems to have gained ground that silver mining does not pay in Essex County.

A glance at the local geology may not be void of interest in this connection. It would seem that the original beds of impure limestone are probably referable to the Huronian Period. These were broken through by eruptive masses that now remain in the form of syenite, diorite, gneiss and various kinds of granite. The lead, silver, gold, zinc, copper, and other metals, dispersed through the limestone as crystals, and often as minute specks, were re-deposited as pockets or veins in the numerous fissures caused by eruption. Large areas of the country are still occupied by limestone, from which formerly lime was extensively made. Here and there masses of serpentine and of a fine-grained green limestone are found, the latter getting its color from the microscopic grains of serpentine diffused through it. It is in the neighborhood of these limestones, often cropping out from diorites and granites, that the metallic veins exist, and usually with a banded structure.

An excellent geological map of Essex County has been prepared by John H. Sears, curator of geology in the Peabody Academy of Science, and was published by the Essex Institute in 1893. The metallurgy of the Newbury mines was thoroughly worked up, in 1875, 1876 and 1877, by Messrs. Shockley, Townshend, Susmann and Baldwin, whose reports are on file amid the papers of the Massachusetts Institute of Technology.

THE HARMONY OF THE SPHERES.*

PROLONGED observations have shown that the distances of the planets from the earth (including the sun and moon among such stars) increase in the following order: Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn.

The ancients reckoned seven planets, and, as the number seven is perfect, no more could be found. So to each of these stars they dedicated a particular metal, viz.: Moon, silver; Mercury, mercury; Venus, copper; Sun, gold; Mars, iron; Jupiter, tin; Saturn, lead.

It will be remarked that the sun occupies the exact center between the planets—a natural position by reason of its size. Beyond the planets are found what are often called the "fixed stars," since their respective distances seem to be invariable, the aspect of the sky remaining constantly the same, while the planets seem to change their places among the constellations with a velocity that is so much the greater in proportion as the stars are nearer us.

* From Houzeau and Lancaster's Bibliographie Générale de l'Astronomie, quoted in Revue Scientifique.

THE SPHERES.

The position of the observer appears to him absolutely fixed—men, animals and clouds changing their position around him. Probably it is the same with the stars. Our first astronomers therefore believed that all the celestial bodies moved around them with velocities so much the greater in proportion as they were distant. The stars and the sun seemed to revolve in describing concentric circumferences, with uniform velocities, proportional to their distances from the observer, the center of the motion, the revolution taking place in twenty-four hours.

According to this first conception, which has at least the merit of simplicity, each planet moves uniformly upon a sphere which has the observer as a center, and with a velocity proportional to its radius. As for the fixed stars, which change their positions all together, as if all of a piece, we may suppose them placed upon the surface of an eighth sphere, concentric with the others and of greater radius.

Unfortunately we soon perceive that the planets have stations and retrogressions, and seem to stop in their motion upon the celestial sphere or even to retrace their steps, so to speak. It is seen, too, that the planetary orbits (that of the moon especially) are inclined with respect to each other. In order to represent such displacements, Eudoxus, a contemporary and friend of Plato, endeavored to enumerate the transparent concentric spheres. According to this author, the moon has three: The first has the axis of the equator for carrying her along in her daily journey; the second has the axis of the ecliptic, which rolls in a direction opposite to the first, and gives the proper motion in longitude, and the third has its axis in the line of the poles of the orbit that produces the latitude. The sun likewise has three spheres, but the planets have a fourth, which produces their synodical revolution. The fixed stars are carried along by the twenty-seventh sphere, which embraces the entire system of the world.

The necessity was soon recognized of increasing the number of these spheres in order to better represent the motions observed. Calippus added seven: Two for the moon, two for the sun, and one each for Mercury, Venus and Mars. There were then thirty-four.

Later on, Aristotle raised the number to fifty-five, and still he was unable to represent all the phenomena.

The complication of such a system was undeniable, and it was necessary to wait for centuries for the advent of Galileo, Tycho Brahe, Kepler and Copernicus in order to obtain an accurate idea of the celestial motions.

THE HARMONY OF THE SPHERES.

The poetic mind of the Orientals, who were passionately fond of music and who were struck with the beauties of the starry sky, quite naturally inquired whether the revolution of these spheres, one with another, must not produce sounds, and, as might well have been expected, the answer was in the affirmative. From the time of Pythagoras, eight spheres were reckoned for the planets and fixed stars. As the diatonic gamut has also eight notes separated from one another by definite intervals, the spheres, if they resound according to the scale of such sounds, will produce music that will be harmonious, and moreover, it might be possible to deduce therefrom the distance of the earth from these planets. The great philosopher occupied himself attentively with the question.

As the Greek lyre had but four strings, and was therefore called a "tetrachord," it gave but four fundamental sounds. So, when it was desired to render a larger number of sounds, two lyres were juxtaposed, either in rendering the junction string central (as in the cithara of Terpander), thus giving seven distinct notes, or else in uniting the two primitive lyres, thus giving eight notes.

Leaving aside the sphere of the fixed stars, Nicomachus took the first combination. Pythagoras, on the contrary, considering the eighth sphere, and thus getting away much farther from the truth, took two complete tetrachords, in adopting the following hypothesis: "The spheres render sounds whose pitch (or number of vibrations) is proportional to their velocity of revolution. The swifter the revolution—or, what amounts to the same thing, the more distant the star is—the more numerous are the vibrations and the higher is the sound produced." It is therefore the sphere of the moon that gives the gravest sound, while that of the fixed stars gives the high octave, the sun producing an intermediate sound.

As every sphere vibrates in unison with a string of the lyre, if we write the notes of the gamut in commencing with mi (according to Burette, who has studied the music of the ancients), we shall have the following results through the association of the tetrachord of the meses with that of the conjoints:

	Moon.	Mercury.	Venus.	Sun.	Mars.	Jupiter.	Saturn.	Stars.
Notes.....	mi.	fa.	sol.	la.	si.	do.	re.	mi.
Distance from the earth.....	1	11/2	2	3	4	5	6	9

If, on the contrary, we admit with Montucla that the octave should go from la to the following la, we shall obtain, upon uniting the tetrachords of the hypates and of the meses, the following numbers:

	Moon.	Mercury.	Venus.	Sun.	Mars.	Jupiter.	Saturn.	Stars.
Notes.....	la.	si.	do.	re.	mi.	fa.	sol.	la.
Distance from the earth.....	1	8/7	4/3	3/2	8/5	2	4	9

We know that the mean distance of the earth from the moon is 60 terrestrial radii, while that of the sun is 24,000, that of the stars being, so to speak, infinite. The absurdity of such a conception may be easily seen.

As a great popular idea is generally found again in different societies at the same degree of their intellectual evolution, we are not surprised to find in the Koue-Yu, an ancient Chinese book nearly contemporaneous with Pythagoras, a long dissertation upon the ratios of the astronomical numbers with those that represent the notes and their intervals and the accords.

The book of Job says that the morning stars sing together. The ancient legends of India tell us that the sounds rendered by the stars form a melodious music—a concert of the Ghandarvas or celestial musicians. If we do not often hear these harmonious accords, say these legends, it is because of habitude, which blunts our sensibility.

In order to explain our incapacity for catching the

sounds of the celestial concert, the Pythagoreans, remarking that a motion that carries us along cannot be perceived without a halt, or at least a modification of such motion, said that the harmony of the spheres is heard only in an absolute calm.

According to Saint Irenæus, certain sects of the first Christians thought that the celestial motions produce a harmonious concert in which the highest notes are derived from the most distant spheres.

According to Clement of Alexandria, the sun sheds its light upon the six other planets that follow it according to the harmonies of a divine music.

Tycho Brahe did not believe in a celestial concert, but he asked himself why we do not hear the whistling produced by the earth in rushing through space. We might ask the same question, with more appositeness, since we know, what he did not, that the earth moves through celestial space with a velocity of 68,000 miles an hour. And we know also that these regions are void, or contain but a relatively negligible quantity of cosmic matter.

Moreover, our earth is surrounded with an atmosphere comparable to the down of a peach. This deadens shocks and stifles any sounds that might be produced. Sometimes, however, small particles of matter as large as the head of a pin, as large as a hazel nut or a hen's egg (rarely larger), meet our globe. If they traverse the atmosphere solely, they become heated and incandescent, and disappear after giving us a train of light. These are shooting stars. If they fall whistling upon the earth or fly through the atmosphere in illuminating it brilliantly, and then burst with a loud report in giving a shower of stones, they are meteorites, whose noise scarcely recalls that of the "harmony of the spheres."

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Manufactured Products in Germany.—It is one of the anomalies of the present situation in Germany that notwithstanding dull and declining home and foreign markets for most products of German manufacture, there is an unusually brisk and insistent demand for certain articles of American origin. During no recent period have so many inquiries, personal and by letter, been received at this consulate from German firms and individuals who wish to be put into direct relations with American manufacturers and exporters, as during the first three months of the current year. These inquiries cover a large range of merchandise, including small machinery of many kinds, typewriters, time and cash registers, furniture and office supplies, shoes, leather, lumber, and even dress goods and other textiles of wool and cotton which, surprising as it may seem, are now produced in the United States under conditions which, it is believed here, will warrant their export to European countries.

The significant and gratifying indication in all this is that American manufactures, as such, are becoming well known in Germany and are appreciated and approved for their quality and price. Here, as in Great Britain, an American label or trade-mark has come to be recognized as conveying a certain guaranty as to general excellence in material, workmanship, and ingenious adaptation to the purpose for which the article is intended. The American machine tool, the high-grade bicycle, dried and canned fruits, the $3 shoe, the typewriter, the roll-top desk and various fixtures have set high standards of excellence in those specialties, and made the way more open and easy for the other manufactured products which are to follow. In respect to all these things, it is but justice to say that with few exceptions, German people, especially in the cities and larger towns, have been just and discriminating in their appreciation of American wares, and do not hesitate to buy the imported article when it is better or cheaper than a similar product of native manufacture. So notoriously is this true that purchasers here are often reproached by trade papers and manufacturers' associations with a want of patriotism and a weakness for imported articles which have the merit of novelty. So marked has been the German appreciation of American machinery and tools that the imports last year included 4,757 tons of machine tools of American origin, against 588 tons from Great Britain and 388 tons from France. Besides this, there was imported from the United States during the same year 20,249 tons of agricultural machinery and implements, 343 tons of electrical machines, 200 tons of steam engines, 574 tons of blowing machinery, and 331 tons of pumps.

But while all this is true, it must be admitted that, except in a few lines, American exporters have been slow in learning the best methods of utilizing the opportunities which are offered in the German market. The makers of machine tools and shoe-making machinery, typewriters, and a few other specialties learned the lesson early and well, and have profited by their knowledge. But, as a class, the American manufacturer—incomparable as such—is still in the primary grade as a merchant in foreign fields. That this should be so is perhaps a natural result of his education and environment. His success at home has been so complete and satisfying, his confidence in American methods so ingrained and assured, that he finds it hard to realize that customers cannot be won in France, Germany, and Russia with catalogues and price lists in English; with measurements, weights, and values stated in inches, pounds, and dollars, and offering to sell his incomparably superior products for "cash at ten days sight f. o. b. New York, sight draft with bill of lading attached."

The folly of all this has been explained and written threadbare in consular correspondence and published reports. It has been emphasized in the letters of German agents and importers, but still the confident exporter goes on in his efforts to "teach foreign purchasers American methods of business." If he ventures upon a foreign language it is almost invariably Spanish, and Germany has been strewn with Americo-Spanish catalogues and price lists which are twice as bulky and no more comprehensible to Germans than if printed in English alone. By way of making it pleasant and easy for the foreign customer, he often incloses a United States stamped envelope, printed with his own address, to contain the returning order. If he sends a traveling salesman or agent to study the market and make personal propaganda, the chances are that the emissary will be a bright, energetic, capable young American, who knows all about the goods and how to sell them in the United States or England, but is ignorant of every language but English and helpless beyond the realm of his mother tongue. Even with these disadvantages, the imperfectly equipped salesman often renders a valuable service by studying the actual needs and conditions of the foreign market, finding how it can be best reached, and, as one of them sententiously remarked, "getting the facts to convince our firm at home that Germany is not in the United States."

In respect to size, beauty of print and illustration, the trade catalogues issued by American manufacturers are the most elaborate and beautiful, as well as the most expensive, in the world, but for practical purposes they are often defective in several respects, the most essential of which are too many claims to superiority and too little definite and exact information concerning the weight, dimensions, and effective capacity of machinery; absence of metric weights and measurements and prices in francs, marks, or other foreign equivalents; and translations, when given at all, made by persons who do not understand the goods, and which are often so incorrect and imperfect as to furnish no adequate technical description of the merchandise. As a result of these defects, intending purchasers are frequently obliged to open a correspondence with the exporting manufacturer in order to obtain clear and definite information. This entails a serious waste of time and often leads to the loss of orders, which are given to manufacturers of other nationalities, who make careful and complete catalogues especially for the German market, or, what is still better, send a capable traveling salesman to exhibit samples or photographs of the goods and make direct contracts in the office of the purchaser.

For the fact remains that with all that can be done by other means, it is the expert salesman—the drummer—who is the most effective nurse of new trade, either at home or abroad. The foreign firms or agents are also important adjuncts when they are trustworthy and enterprising, but there is always the possibility that they will hold back the sales of an imported article while pushing those of native production, or they may take advantage of loosely drawn patent and trade-mark laws to improve their own product at the expense of the foreign competitor. All this is but natural, and must always be taken into account by exporters who place their goods in the hands of foreign agents who are already established in a similar line of trade. Many of such houses in Germany have been enterprising and faithful and have built up an important and permanent traffic in American specialties. Others have utilized the opportunities thus acquired to use the imported machine or other article as a model to improve their own products, which they have pushed into complete control of the market.

There should be therefore a closer acquaintance and more binding agreement between exporter and agent, and this can be acquired only by personal contact and a more careful study of the conditions and requirements of European trade, made here on the spot by competent merchants or expert salesmen. In large enterprises, the sale of machinery and tools, sales of railway supplies, mining equipments, contracts for bridges, etc., our people have achieved brilliant successes because they have come abroad and done the business directly with purchasers. The enormous increase of the German export trade during the past twenty years is a monument to the efficiency of the good-natured, persistent, highly educated German drummer, who, with sample bag and order book, backed by subsidized steamship lines and German branch banks in foreign marts, has camped in the remotest markets of the earth until he has practically made them his own.

It is an ungracious though sometimes a wholesome duty to point out some of the other errors into which certain of our exporters have fallen through careless overconfidence or ignorance of foreign conditions, and to state from the standpoint of the German importer some of his grounds of complaint. The first of these charges is that American exporters are in many cases too lax and irresponsible in the fulfillment of contracts. As an example of what is meant by this, the following incident will serve: In August of last year, a furnace company in a Southern State sold through an agent in Germany to a steel manufacturer in the Lower Rhine region 5,200 tons of pig iron, with the express stipulation that 4,000 tons should be shipped so as to be landed at Rotterdam on or before November 15, and the remainder to be landed at Hamburg not later than the same date, so as to be shipped up the Elbe to Silesia before the close of navigation. There had been a dearth of pig iron in Germany during the summer and early autumn of last year, and the purchaser waited impatiently for the American material. Letters and telegrams to the seller evoked no satisfactory reply. The autumn boom in steel manufacture had begun in the United States and he was taking care of his friends at home. Finally, on the 20th of December, 200 tons arrived at Hamburg. The Elbe was then frozen so that it had to be shipped inland by rail. The remaining 1,000 tons of that order and the 4,000 tons for Rotterdam failed to arrive, and the order was canceled. The Rhineland steel maker accepted the non-delivery because an important decline in the demand and prices of steel had meanwhile occurred in Germany and he could dispense with the American pig iron. But had this been otherwise, he might have bought the whole 5,000 tons in England, Germany, or anywhere, paid the market price for it, and collected the difference between that and his contract from the agent who sold him the American metal and failed to deliver it according to agreement. It should be clearly understood that under German laws, non-fulfillment of contract is a misdemeanor for which the delinquent can be made to pay both actual and contingent damages.

It follows that the German agent of the American exporter, selling goods on commission and depending upon the promptness and good faith of his principal not only for the stipulated delivery, but for the quality of the merchandise, is placed by any default in an exceedingly risky and delicate situation. Being a German subject, he is held subject to the laws of Germany in respect to all contracts made for fulfillment in this country. If he fails to deliver the right goods at the right time, the purchaser may at his option cancel the contract or cover it at the risk and account of the commission merchant who represents the foreign seller. Against the honor and good faith of most American exporters nothing can fairly be said, but there are in several lines of business firms of easier conscience and sharper methods who do not hesitate to conduct their export trade on the ethical basis of a horse trade and who stoop to practices which are complained of by the victims to their local chambers of commerce, are reported and discussed in newspapers, and furnish the enemies of American imports with just the ammunition that they crave.

Among cases of this kind which have been complained of at this consulate during the past few months have been one in which a large shipment of grease for candle making was found adulterated with 28 per cent of water, and the exporter made a stubborn fight against allowing the discount justified by such fraudulent qualities; others in which machinery has been damaged in transit by reason of frail, imperfect packing, and scores of cases in which California prunes and other dried fruits are not graded at all, except that one layer of selected pieces representing the grade sold is laid on the top, while the remainder of the box is filled with small, discolored, and wholly inferior fruit belonging to a different grade and bearing a wholly inferior price. This abuse has been so flagrant that certain associations of fruit growers in the Pacific States have been organized to grade, pack, and control the quality of their aggregate products; but the reform is not yet complete, and a recent shipment of dried peaches from San Francisco has been one of the worst on record.

In no market of Europe will any trickery of this kind—any lapse whatever from absolute honesty and good faith in the fulfillment of a contract—entail such fatal consequences as in Germany, where every detail of commercial practice is strictly regulated by law, and where the purity and excellence of food products are guarded and enforced with a rigor which is all but fanatical.

Another point that few American exporters seem to grasp is that articles made from several different materials—as wood, steel, nickel, and copper—are uniformly classified for duty in Germany under the constituent material which bears the highest rate of duty. This has led to some queer and seemingly irrational decisions, as, for instance, where canned vegetables were classified as tinware because the duty rate on tin is far higher than on vegetables. When, therefore, machinery or other merchandise includes parts which are nickeled, upholstered, or otherwise specially decorated, such parts should be packed separately. Letters or catalogues should state precisely not only what the article weighs, but how many cubic feet of space it occupies when packed in the smallest practicable compass for shipping, and whether the individual parts are of steel, brass, iron, wood, or other material.

While it is probable that the imports of American machine tools, electrical and even agricultural machinery, may show a marked decline during the current year as compared with 1900 and 1899, there is yet an unsatisfied demand for a wide range of novelties and special inventions in which American ingenuity and adroitness in manufacture have produced something strikingly superior to what is known or used in this country.

As an indication of what is meant may be cited the recent inquiry of a leading importing firm at Berlin, which solicits information and propositions from makers of the most modern and highly improved centrifugal machinery for chemical and laundry purposes, filling machines for charging small paper bags with groceries and medical preparations, filling bottles with salts, etc., and machinery for making pastilles and lozenges of all kinds. It is well known that in these and many other specialties, though not in all, American machinery is unequaled; but there is a lack of means for obtaining here exact knowledge, not only of the latest improvements, but of their weight and cost. Dealers with experience, ample resources, and knowledge of the German market are numerous and ready; it is the American salesman with samples and specifications who is generally lacking.

Finally, the American manufacturer who seeks to establish a market in an old and well-supplied country like Germany should realize that it costs something to advertise and introduce a new article, and ought to be willing to pay part of the expense of the enterprise. This he can do by an allowance for advertising purposes, or by granting a longer credit for the goods themselves. Before giving the exclusive agency of a product to a single firm, the exporter should know with whom he is dealing; but, once satisfied on that point, absolute faith should be kept. Many an American exporter has spoiled his chance with the best German importers by sending mailed circulars and propositions broadcast, whereas the article was one which required a special representative agency for its proper introduction. Few responsible houses will undertake the introduction of a new kind of merchandise which any competing firm can obtain direct from the American exporter. In all these respects, business men are very much alike the world over, and it is always a wholesome process for the seller to imagine himself on all questions of detail in the position of the buyer, and consider what he would or would not be willing to do if their relations were reversed.—Frank H. Mason, Consul-General at Berlin.

Trade Methods in Germany.—I am constantly in receipt of letters, catalogues, etc., from our manufacturers and export associations, wishing to introduce American goods into this district and requesting the names of reliable purchasers. Inquiries are made by this office and information is promptly given.

In order to find out whether my work had led to satisfactory results, I called of late on some prominent merchants here and, while it gave me pleasure to learn that my endeavors had been partly successful,

I was told that our exporters are at fault in some respects. It is for this reason that I submit the following as the most interesting part of my interviews, to serve for the information and guidance of our shippers.

In the first place, it is admitted that our manufactures excel in variety, beauty of style, and adaptability all others, wheresoever made. Letters, circulars, catalogues, etc., in English are, however, of almost no value, and those who desire to secure this market for their goods must pursue the methods that are principally used here. The most effectual means would be the canvassing of every city and town by intelligent agents with samples of the goods they sell, and with full knowledge of every detail of their special lines, so as to give all information desired. A careful study could in this way be made of the tastes and peculiarities of the region, and full particulars of the requirements of this market could be sent home. Moreover, careful inquiries could be made with regard to financial standing of buyers.

My attention was also called to the disinclination of many of our manufacturers to adapt their fabrics to the habits and tastes of other countries. They are averse, it seems, to deviating from their usual sizes, forms, etc., though it would seem that when a new market for certain articles is to be acquired, the goods should be made to suit the wishes of the purchasers.

Moreover, it was said that American manufacturers are often anxious to make large sales at the start, without considering that new articles can be introduced to consumers only by the expenditure of much patience and perseverance.

Great fault is found with our terms of credit. While the business in this country is mainly done on terms varying from three to six months' time, our merchants insist in many cases on cash on delivery and even before delivery, so that receivers are unable to examine goods before payment and can not know whether the shipments are in accordance with orders or not. Of course, the demand for cash on receipt is well justified if the purchaser's financial standing is of a questionable nature; but I know of first-class German houses that have been subjected to the same rigid terms, causing a discontinuation of purchases and material losses to our trade.

Another point one of my informants laid stress on was the packing of our goods; the greatest precaution should be used in this regard. Care should be taken to prevent breakage and no old or damaged cases should be used. As the customs duties are levied here on the gross weight, less a certain percentage for tare, the advantage of lightness in packing is essential. Manufacturers who ship goods to this country should thoroughly acquaint themselves with the German tariff, and pack their goods in such a manner as to save the purchaser trouble and useless expense. For instance, a much higher duty is charged on nickel-plated iron than on cast-iron stoves. American shippers of stoves will therefore act wisely if they separate the nickel-plated parts and pack them in one case and the heavy iron parts in another, so as not to have the receivers pay the higher duty on the entire weight. The same is true of many other articles. —Charles Neuer, Consular Agent at Gera.

Alleged Process of Preserving Butter.—Consul Freeman, of Copenhagen, under date of April 22, 1901, says:

I am in receipt of so many inquiries from the United States in regard to the reported discovery of a new and successful process for preserving butter, meat, eggs, etc., that I am led to suggest that notice be given in the Consular Reports that the so-called discovery is a failure. The alleged inventor applied for a patent, but his application was rejected. The sealed package of butter which was presented as a test of the process bore a notary's certificate as having been sealed up in 1900, but it was proved that the butter had been preserved only a few weeks, the date—February, 1901—having been surreptitiously changed to read February, 1900.

Combination of Scandinavian Match Factories.—Under date of April 26, 1901, Consul Bergh, of Gothenburg, says:

The Gothenburg Post contains an article which in translation reads as follows:

According to the Copenhagen newspaper Borsen, the negotiations concerning the combination of the Scandinavian match factories are now nearly completed. The combination will include all the Danish match factories and several Swedish and one English match factory, which together will form a large joint-stock company, with a capital stock of about 5,400,000 kroner ($1,447,200). No new shares will be issued for the time being. The company will have offices in the free port at Copenhagen and in Hamburg and London.

Dock at Corinto.—Consul Donaldson reports from Managua, April 12, 1901:

The government of Nicaragua has signed a contract with Mr. T. Solomon, an American citizen residing in Bluefields, for the construction of a dock at the port of Corinto. The dock is to be 500 feet long by 315 feet wide and to be constructed of iron; it is to cost $150,000 gold and to be ready for public use within one year. As compensation for the capital invested, Mr. Solomon will be allowed to collect from 10 to 15 cents per cwt. for freight and 10 cents for each passenger embarking at or disembarking from the port.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1047. May 27.—Resources of British Guiana.—*Prevention of Frost by Cannon and Smoke.—*Coal in Germany.—*Zinc Poison in Colored Hosiery.—*Tea in Caucasus.—The Kaiser Wilhelm Canal.

No. 1048. May 28.—*Packing Goods for Foreign Markets.

No. 1049. May 29.—Commerce of China in 1900.

No. 1050. May 31.—Exhibition of Decorative Art at Turin.—Trade Trade with Malta.—Shipping Goods to Malta.—Export Trade Notes.—Increased Tariff in Costa Rica.—*German Demand for Linoleum.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRICK ELKS AT THE CRYSTAL PALACE.

HERETOFORE probably no attempt has ever been made to train deer. That this task is very difficult ought not at all to surprise us when we consider the shyness of all deer. Owing, however, to the extraordinary perseverance and patience of Mr. H. Barnes, an American, three elks after two years of hard work have been successfully trained to an unprecedented degree. These animals, at present making a tour of Europe, were recently exhibited at the Crystal Palace, London, after they had attracted widespread attention at the Paris Exposition. Their chief feat is a leap from a 33-foot platform into a comparatively small, but deep, basin of water, in which they disappear for several moments. All this is done without any special compulsion from their master and with amazing calmness and grace.

PREPARING FOR THE DIVE.

Mr. Barnes relates that he accidentally conceived the idea of training elks; and it seems he has a special endowment for it, as no one heretofore has been able to accomplish anything of the kind with these animals.

At the performances given by Mr. Barnes at the Crystal Palace, in London, no other preparations had been made than the building of a gangway from one of the upper galleries into which the elks were led. Below there was constructed a tank 12 feet deep into which the animals leaped. The two young elks Rex and Reno, though only a year old, have learned their task quite quickly because the older elk Ringlet was a good teacher. At first, however, they would gaze with fear at their older companion, but seeing that no harm befell him—and that, on the contrary, after a performance, he always received from his satisfied master a reward in the shape of a piece of sugar—they readily made the difficult leap.

All three elks were caught in the Rocky Mountains, Montana, where Mr. Barnes trapped them. To catch these animals caused much trouble and consumed considerable time, because elks are scarce and nearly extinct. Ringlet is an exceptionally beautiful elk weighing more than 800 pounds. Had his antlers been allowed to grow, they already would have reached a span of at least seven feet. However, as there are no special cars for elks on the railroads, Mr. Barnes found it necessary to apply a special preparation to the antlers every spring to prevent their further growth. This precaution is entirely harmless to the animal; in fact, Mr. Barnes is of the opinion that the extraordinary strength and exceedingly good health of the animal is due to this treatment.

The elks are also used as draught-animals, and are harnessed to a wagon by their trainer. Although their dive makes a greater impression on the audience, still their drawing a wagon is in reality the more astonishing feat. Shy animals, that have roamed about the forest, could only with the greatest difficulty be made to accustom themselves to wear a harness and draw a wagon. The older elk Ringlet for more than a year strenuously resisted all attempts to put him into the yoke, and Mr. Barnes states it is hardly possible to count the accidents incident thereto. Now, however, a ride in his elk wagon is just as safe as though it were drawn by horses.

The care of the animals also requires considerable attention. After every drive they must be carefully rubbed down and dried. As soon as they have left the water they are wrapped in large blankets and rubbed until they are perfectly dry and warm; thereupon they are wrapped in warm blankets. Their food also demands much care and precaution, so that the care of these animals is almost equal to that of a race-horse.

THE DIVE.

TEA SHOPS OF BOMBAY.

APROPOS of the Indian Viceroy's suggestion at the famous meeting on the Assam Labor bill, that the planters should relieve some of their present diffi-

culties by exploiting India, The Indian Daily News describes a great industry which has sprung up in Bombay in recent years, and which appears to have been quite overlooked by those who are promoting the Indian market for Indian tea. In want of a better term to distinguish it, we shall call it the "Iranee Industry," from the people who are chiefly engaged in it. Some years ago the Parsees of Bombay were much distressed by the trials and disabilities of the followers of Zoroaster who still remained in Persia, and started a fund, which, we believe, is still in existence, to relieve them. The forms of relief were several, the chief being the support of an agitation to represent matters at the court of Persia, and this we know met with great success, the lot of the Persian who is not a follower of Mahomet being much better to-day than it was some years ago. Among the minor forms of relief was assistance given to poor and needy "guebers" (as they were called), to emigrate to India. These men arrived in small batches at Bombay with their wives and other goods, and then the problem arose as to the manner in which they were to earn a livelihood. They soon settled it themselves. They are a hardy race of men, somewhat like Jews or Armenians in appearance, thrifty, and with the instinct of the small shopkeeper greatly developed. All they asked from their coreligionists was to give them a start, and they promised to do the rest themselves and keep from beggary.

As "gueber" is a term of reproach, these men were popularly called "Iranees," to distinguish them from the Indian Parsees. They distributed themselves over the city, and opened small shops for the sale of aerated waters, tea and coffee, to be drunk on the premises, and cheap cheroots to go away with. The idea "caught on," as the Americans say, like hot cakes. These shops were in the proximity of large labor yards, and the laborers, whether Goanese, Christian, Parsee, Mahometan or Maharatta Hindoo, got in the way of dropping in for a cup of Iranee tea, which was sold for two pice, this including milk and sugar. The staff who worked the shop consisted of the old man, his wife and a youngster or two; no servants. It will be seen that the utmost economy was observed, and when was added to this a tireless industry it was only natural that the enterprise should thrive and gradually develop. The Iranee was a farseeing man of business, and recognized before long the directions in which he could expand his shop. Tea was his mainstay, but tea alone is not sufficient to satisfy a hungry man. A loaf of bread of really good quality was added to the cup of tea, and the lot sold for three pice, the purchaser having the option of taking biscuit instead of bread. The customers increased in numbers, and the shop grew in size until it assumed the proportions of a decent restaurant, where there was plenty and clean, if a little rough. The Iranee's popularity grew with his prosperity. Some of the more ambitious established regular cook shops, into which the poor but respectable European and Eurasian was not ashamed to go for a cheap and satisfactory meal. These men are perfectly indispensable to the laboring population, especially such as have to leave their homes before daybreak and before it is possible to get any food ready. As far as we have been able to ascertain, adds the journal, the tea used by the Iranee is what they sold in the Bombay market as dust tea, and presumably came from China. He had to use it because it was the cheapest he could get, and Indian tea was hardly pushed at all in Bombay. We have no accurate statistics to guide us, and cannot, of course, tell how four years of plague have affected the number of shops, but we do not think we are making an exaggerated estimate when we put the number of these small tea shops down at one thousand, and half of them at least consume several thousand pounds of tea in the month. Here then our tea planters have a certain and large field of operations, and should lose no time in starting.

ELECTRICALLY OPERATED RADIAL DRILLS.

A DRILL press furnished with an electric motor makes a very complete equipment for a tool room and other work of like character. The elimination of line and counter shafting on the machine is very important as regards economy of operation, as the power consumed in transmitting power to a press by means of line shafting is often nearly twice as much as that actually consumed by the press. This is particularly true of small machines, and when the machine is only operated intermittently, as by line shaft transmission, the power consumption goes on regardless of the shutting down of the press, while with the electric motor as a driver the power consumption ceases with the shutting down of the press. The accompanying illustration (Fig. 1) shows an electrically operated upright drill constructed by the W. F. & John Barnes Company, of Rockford, Ill., and operated by a Northern steel multipolar direct-current electric motor. These outfits will be exhibited during the coming summer at the Pan-American Exposition at Buffalo, as well as many other electrically operated tools of an interesting character by the Northern Electrical Manufacturing Company.

Radial drills have been operated by electrical motors mounted vertically as well as horizontally, and for single radial drills as well as double radial drills with rotating arms. The accompanying illustrations (Figs. 2 and 3) show both of these types of machines as designed and constructed by the Niles Machine Works, Hamilton, Ohio. The motors are in each case mounted at the top of the tools and are controlled by switches and rheostats mounted at the base of the machines.

It is conceded by many of the most prominent engineers that it is almost invariably best to drive all machines consuming more than three or four horse power by individual motors. The expense is probably much more than when several machines are operated by one larger motor, but with separate motors the speed can be varied according to the work done. It is also possible to obtain the different speeds required by nearly all machines under different conditions, the motors being direct connected and supplied with controlling rheostats.

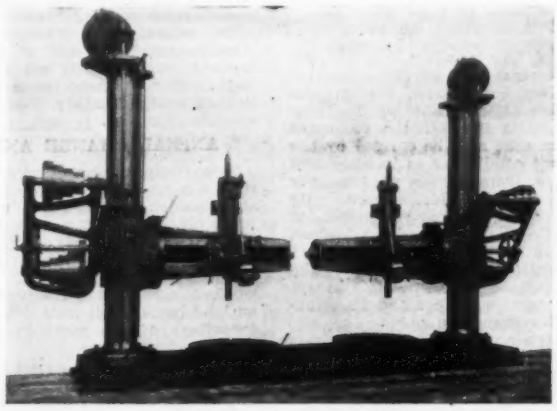


FIG. 3.—ELECTRICALLY OPERATED TWIN RADIAL DRILLS.

By making the tool and its operating motor a self-contained unit many advantages are noted, as it may be picked up by a traveling crane and located in any part of the shop; it would be easy to operate any machine with attached motor in any place to which a wire can be run. It is thus found possible to move the working tool to the heavy casting to be operated upon instead of moving the enormous casting to each of the various tools about the shop. It is even possible to have a number of tools brought to the same casting, all of which may be working at the same time on very large work, thus saving much time and labor and increasing the output and the cost of same.

LOUD-SPEAKING RADIOPHONE.—T. Tommasina has constructed an electric radiophone which can be heard throughout a large hall. It is not so sensitive as previous patterns, but still responds to exciter sparks of only 1mm. length. No relay is used, and the

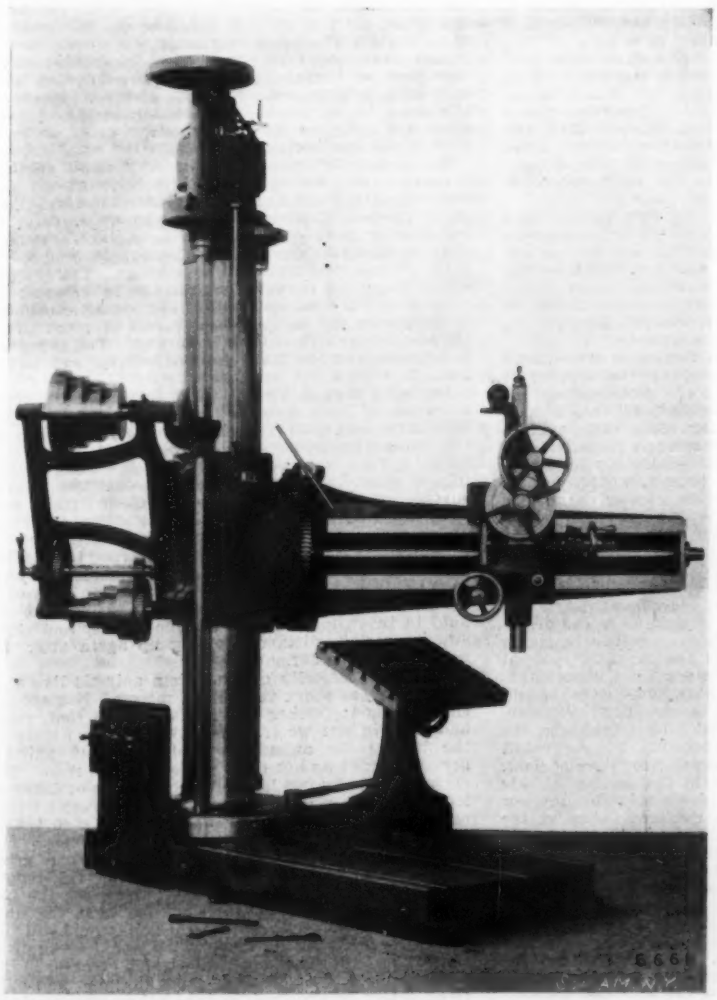


FIG. 2.—RADIAL DRILL OPERATED BY ELECTRICITY.

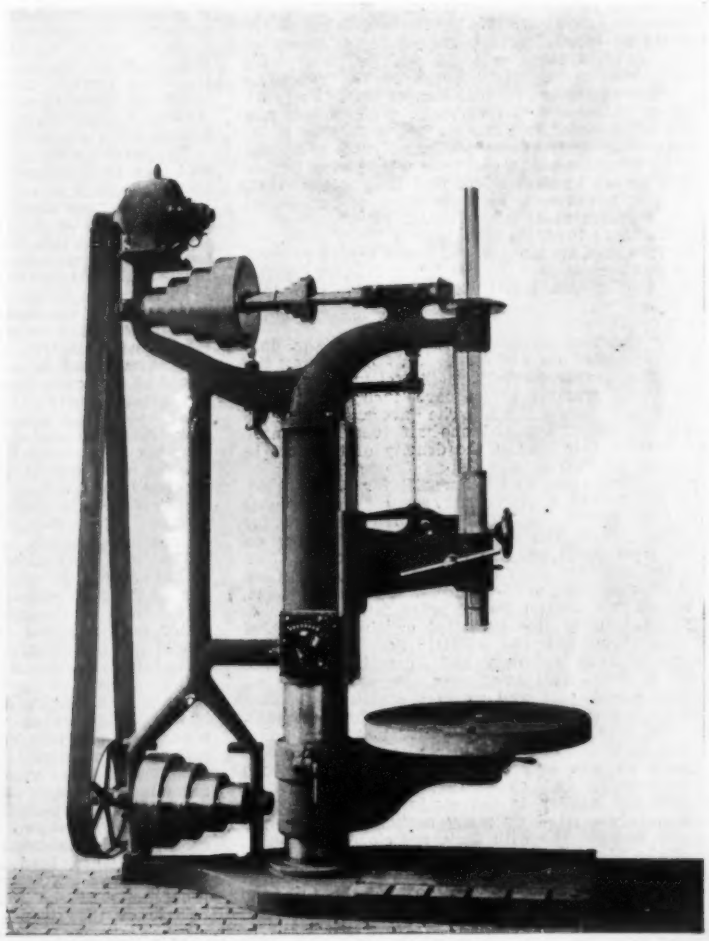


FIG. 1.—ELECTRICALLY OPERATED DRILL PRESS.

receiver is simply in circuit with a battery and a telephone. While in the ordinary coherers the particles must be free to move, they are embedded in a pasty mass in the new coherer. The author employs silver filings mixed with lycopodium, sulphur, or glass powder, and embedded in glycerine. The electrodes are platinum coils wound on glass. Electric waves impinging upon this coherer produce an increase of resistance which, however, only lasts as long as the impact lasts. The coherer is, therefore, self-righting, and to such an extent that the author declares it to be an interrupter controlled by electric waves. Its efficiency, as such, is directly proportional to the strength of the current traversing it. At a certain critical current strength the galvanometer needle becomes nearly stationary, while the telephone responds vigorously. This shows that the interruptions are practically instantaneous.—T. Tommasina, Comptes Rendus, March 11, 1901.

DUST STORMS AND RED RAIN.

IN previous numbers of The Monthly Weather Review we have described several dust storms; a general article on that subject, by Prof. J. A. Udden, was published in The Popular Science Monthly for September, 1896. In this article Prof. Udden estimates the load of sand and dust that may be carried by the atmosphere under different conditions as to wind and soil. His estimates vary from 0.0009 gramme per cubic foot, or 160 tons per cubic mile, as appropriate to a thick haze up to 0.77 gramme per cubic foot, or 126,000 tons per cubic mile in the case of the highest estimate based on the quantity of sand found in dwellings. He finds the quantity of work done by the atmosphere in transporting soil to be about 1-330 of the work done by the Mississippi River and its tributaries over the area of its watershed.

Recently the newspapers and scientific periodicals have contained accounts of a remarkable storm with falls of red rain or snow and red dust throughout southern Europe.

The International Decade Report for the first ten days of March says:

"On March 10 and accompanying a depression traveling from Algeria to Pomerania, there occurred a sirocco with red dust in the morning in Sicily, in the afternoon in southern Italy; on March 11 there fell red and yellow dust generally with snow northward in Brandenburg and Pomerania, with east wind by midday, and over the lower Elbe and Weser with north wind by the evening of the 11th."

Prof. A. W. Rücker, of England, who had been staying some time at Taormina, in Sicily, communicates the following interesting report. (See Nature, March 28, 1901, page 514.)

"On March 12 the sirocco was blowing and the hills were wrapped in mist, but the fog assumed a yellow hue, and the sun, which at times could be seen through it, was a bright blue; this was caused and accompanied by a copious fall of red dust. Some which I shook off my hat was quite dry, and on looking at it through a low power lens all the granules seemed to be spherical, except a very few grains which looked like quarts. Of course, the question was raised whether Etna was ejecting something which corresponded to the Krakatoa dust, but this was negatived by the fact that the Italian papers state that the dust fell also at Naples and Palermo in such quantities that the streets looked red and the people were frightened. I scraped some off a marble table which I send you.

"Under the microscope this dust is seen to be mainly composed of inorganic particles, chips of quartz in small quantities being mingled with minute plates of various micaceous and other minerals. There is also a fair admixture of frustules of fresh water diatomaceæ, entire and in fragments. The number and variety of these diatomaceæ do not appear to be so striking as in some of the celebrated cases described by Ehrenberg, the organisms from which were figured by him in his Passant Staub und Blut Regen, 1847. There are, however, a very considerable number of species represented in these recent falls."

On March 20 Prof. Rücker says:

"At 7:30 this morning the sky was copper colored, and it was evident that another fall of dust was taking place. The sirocco had been blowing for two days and it was raining slightly. The sky ceased to be copper colored about 8 or 8:15 A. M."

Under these circumstances he measured the dust that accumulated on various flat surfaces during the hour. The measurements gave the following results:

(a) 0.0010 gramme per square inch; (b) 0.0017 gramme per square inch. The average of these 0.00135, or about five and one-half tons per square mile, gives a fair idea of the density of the dust in the region of Taormina.

In the Meteorologische Zeitschrift for March, 1901, pages 137-139, is a preliminary report on the dust storms of March 10, 11, from which we take the following items: The chart shows that a depression passed from the Algerian coast across Sardinia, Corsica, and northern Italy in a northeastern direction, and on the morning of the 12th was over west Prussia. Attending this distribution of pressure strong sirocco and high temperatures prevailed on the morning of the 11th throughout the Adriatic Sea, and the phenomena of 1879, February 24-25, described by Hann in his Meteorological Atlas were now again repeated. On that occasion as well as on the 15th of October, 1885, when a storm center moved over the same path, dust fell over Italy and the southern Alps and red-colored snow was observed near Vienna.

The dust was examined by Prof. Perhanz both microscopically and chemically, and was found to be perfectly similar to the sands of the Desert of Sahara, as described by many authors. In Palermo the sky was covered with dark, red clouds after 8 A. M. of the 10th. The whole city appeared bathed in red; at noon time the drops of heavy rain looked like blood. At Naples, about 5:45 P. M. of the 10th, the sky became bright yellow and afterward fiery red. The clothing of those in the street was entirely covered with dust. It was difficult to keep the eyelids open. Nothing like it had been seen in Naples since the eruption of Vesuvius in 1872. The phenomenon lasted about three hours.

On March 11 similar dust rains, or blood rains, prevailed over northern Germany. More complete reports are promised by Hann and Hellmann. One can easily see that we have here to do with a severe storm in the Sahara region, and by the attending winds the finer dust was raised and transported northward. Prof. Salcher states that the dust is sirocco sand. Although the microscopic study of the dust in Germany has, so far as noted, revealed only mineral dusts, yet the editor cannot doubt that eventually diatom dust will also be found, similar to that which occurs when the harmattan carries the dust of the Sahara toward the west and southwest over the Atlantic Ocean. These diatoms are characteristic of the fresh-water marshes and ponds of the Sahara Desert.

This is the first time that Sahara dust has been known to be carried to England. The black rains of April, 1887, in Ireland, were undoubtedly due to the soot dust of soft-coal fires.

In January or February, 1890, the steamship "Queensmore," arriving at Baltimore from England, reported red rain and red dust off the coast of Newfoundland. It would be very remarkable if this was Sahara dust.—Monthly Weather Review.

ANIMAL CHANGE AND ENVIRONMENT.*

THE surface of the globe when considered with reference to the places in which animals can originate and flourish affords three main localities: the land, fresh water and sea. Of these, the sea is far the richest in individuals. The most species occur on land; while there are both fewer species and fewest individuals in fresh water. From another standpoint we find in the sea a greater diversity of animals than on land or in fresh water; the sea also contains representatives of the most primitive groups in greater number than either.

Among groups of animals limited entirely to the sea are the medusæ—the jelly-fishes (the greater part of them); all the corals (the greater number of the polyps); the sea-urchins and the star-fish, the sea-squirts, or tunicates; and of fishes, all the sharks. The large groups of animals found in the sea are mainly primitive: groups from which other groups have been derived.

The land fauna is of quite a different character. In it are almost all the insects, there being exceedingly few fresh-water or marine insects in comparison with the terrestrial ones; and on the land are most of the spider group. Those together make up the great majority of all animal species known.

What is the relation of all this to the question, In which of the three places, fresh water, sea or land, animals arose? The fact that we find the more primitive groups confined for the greatest part to the sea would show that perhaps the sea has been the ancestral home of animal groups; and all the evidence that we have to-day makes that a very probable conclusion.

In the early geological times, in the cooling of the earth's surface, there was a much greater amount of water than at present, and all was salt water. The dry land was insignificant; fresh water almost nothing; the only place at that time in which animals could have lived must have been salt water. Hence, if animals first developed about that time (which is very probable from the remains we have of them in the early sea deposits), they must have been marine.

There are two very different views as to what kind of life those primitive animals led in the sea, wherein we may distinguish animals as free-swimming or pelagic (living on the surface); then the strand fauna (living on the rocks, say, between high and low-water mark); finally, the bottom fauna. Upon which of these was the starting point will depend altogether our conclusion as to the relationships of a good many groups of animals.

The view widely prevalent until very recent times was that the original fauna were the free-swimming animals, which is the view of Prof. Brooks particularly; that from them on the one hand developed the strand fauna; on the other, the bottom animals; and the reason for this view is that the most primitive ancestors that we know of, the vertebrate animals, are forms which live on the surface entirely.

The struggle for existence in the sea is exceedingly intense: it is something tremendous, the number of individuals of a species that are destroyed in all ages; both an active, direct struggle between animal and animal and a struggle for food. The surface would be the scene, then, of the struggle for existence: any animal leaving the surface, giving up its swimming habits and going to the bottom, would, on this new feeding ground, have a much greater chance for life; but at the same time in getting out of the struggle for existence it leaves aside the great factor causing it to develop. Hence, among animals leaving the surface and going to the bottom there would probably arise a degenerate mode of development: not a progressive, but a regressive, development.

That is the prevalent point of view as to the origin of animal life from the surface. Another seems to me much more probable: that the primitive animal forms lived on the edge of the sea from about high-water mark to two or three fathoms (the strand zone). The author of this theory, Prof. Simroth, claims that on the strand zone there would be the water, oxygen and land all together at one point, making it the region most favorable for development. If the original animals started in the sea just at this zone, there could be lines of development leading out to swimming forms living on the land. And at the strand zone there would be the greatest struggle for animals to maintain themselves against the strength of the tide and the action of sun and air.

Which of those two theories is the true one? Our earliest geological remains go back very far short of the time when land animals must have originally lived, and we can say nothing at all about the oldest inhabitants of the sea. But certainly either the pelagic or the strand life was the point of origin for all living animals; and we can prove that from the vegetation, which determines the distribution and mode of life of all animals because it is the food of all directly or indirectly. An animal either directly feeds upon vegetation, or upon another animal which does; and knowing that probably the original plant life was not a floating life on the surface, but was limited to the strand zone, the animals must have lived there because their food supply was at that place.

Rivers are very much more recent in origin than the sea: our present continents are of comparatively recent formation; and though there have been previous continents much greater than these (as, for instance, a continent in the middle of the Pacific Ocean which has gone and left its mountain peaks as a great number of small islands in the Pacific), there is no doubt that the land is very much greater in extent now than formerly, and also formerly there was no fresh water—only salt water. From such forms which live on the strand zone we could have free migration up rivers—the case possibly with some mollusks; but very much more probably, most of them have accustomed themselves on the strand zone to living gradually a little more and more above the tide—first at low-water mark, then a little higher, and so have accustomed themselves gradually to a land life. Land animals could be formed in still another way: around many bodies of salt water are salt marshes; animals may wander in there (as many marine worms and shell-fish), getting to gradually shallower places; these marshes, drying up periodically, would periodically accustom the animals to dryness and an ultimate land life.

Animals getting onto land can again go back into the sea—a great many of the forms have probably passed through such a life history. Some mollusks which to-day are both fresh water and marine had exclusively salt water ancestors; we know also animals coming from the fresh water onto land and from land into the fresh water, and all possibilities of different migrations of animals from one element into the other.

What are the changes animals undergo through these interelemental migrations? An animal used to surface life on the sea could not conceivably, without change, accustom itself to a land life; and no animal accustomed to a water life can live successfully on land.

We have a great many facts which cannot be explained in any way but by the doctrine of descent with modification. That is our main knowledge of evolution to-day. It is, however, chiefly circumstantial evidence. We know some cases of closely related species of snakes, one living in the fresh, one in the salt water. (I have in mind one of the East Indian species.) The marine has quite noticeable variations of structure from the fresh water species, though in other points much the same. We cannot say that the marine snake was originally created in the sea: all the evidences of geology show snakes were originally land forms, as were all turtles, though to-day some of them have accustomed themselves to fresh water and some to the sea. The sea snake has developed its structure differently from the land snake, owing to different environment.

In the marine surface fauna we find the free-swimming forms have no development of a skeleton. This well illustrates the doctrine of the utility of each character: there is no such thing as the development of a useless character. Animals with very active motion have very little development of skeletal structures; those having very little active motion present such development. It is the greatest advantage, of course, to the surface animal that it should have about the same specific gravity as the water, so as to require the least swimming force.

The Copepoda are a group of very small animals averaging, say, an eighth of an inch in length; and they occur in greater number of individuals than any other species of animals that we know, constituting the greater part of marine surface life. We find, floating with the jelly-fish, the Ctenophores and many little worms that live on the surface. Their mode of life is moving forward, swallowing the water ahead of them as they go, and in that swallowing continually taking in the microscopical forms of plant life—the diatoms—which is their main food. The Copepoda are themselves the main food of whales and larger fish.

During a rain on the sea there falls on the surface a coating of fresh water which does not immediately sink to the bottom: four hundred miles out to sea from the Amazon's mouth there is a coating of fresh water which has not yet mixed with the salt. Such a coating of fresh water would immediately kill marine surface animals; so very many of them have a sort of hydrostatic apparatus for sinking down a certain distance from the surface, and that is apparent in the Radiolaria, which have oil globules giving them great lightness. When filled with these oil globules it by its own lightness stays at the surface; but in case of a rainfall the animal compresses these—drives out the fluid in them, increases its specific gravity and sinks down a certain distance, coming up again after the surface becomes normal.

The great majority of sea-bottom animals live at a depth of from about two to ten meters. Nearest the shore is sand; further out, rocks; beyond that, rocks and mud in the water. According to the nature of the bottom the animals will differ. Mud animals are so adapted as not to be choked by the mud. The clam breathes by two long projecting tubes of different lengths called siphons. A fresh-water mussel living on a sandy bottom in clear water has no such tubes: it respires the water through breathing holes. The clam, however, lives buried in the sand to a great extent, breathing the water in through the longer tube and out through the shorter. Now see the use of that adaptation! Had the clam, buried in the mud, no tubes, every time it breathed it would fill its breathing cavity full of mud, which would accumulate and suffocate it. The longer tube which breathes in the water projects up well away from the mud and only clean water is breathed in; the other tube need be only so long as to carry its orifice a little above the mud. Forms like clams possess a very friable

*A lecture delivered at the Wagner Free Institute of Science, Philadelphia, by Prof. Thos. H. Montgomery, Ph.D., of the University of Pennsylvania. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

shell and many enemies such as larger fishes; and they will sink into the sand to hide away from danger.

Among the annelid worms (marine representatives of our earth worms) are surface forms swimming about with great rapidity. Their relatives on the bottom show a striking difference from the surface ones, and some have no skeletons whatsoever, but a well-developed head-end with eyes and sense tentacles. The body has numerous segments on which are little, projecting, branch-like leaves—the gills with which they breathe. Many annelids change when they live upon the bottom through a series of modifications very much as in the clam. The earliest change noticed is secreting slime over themselves, and particles of sand, and the ooze of the bottom adhering to that sand forms a hard, protective shell. Often this slime is poisonous and distasteful to other animals. Very often there is developed a strong shell of horny substance around the posterior end, the worm projecting from the shell with its head up; sometimes, in place of the horny tube, a stony one. These clear white delicate tubes make up great masses of rock somewhat like coral in appearance. The animal living in such a tube has undergone very great changes: a marked development of the portion projecting out of the tube and a degeneration of all the posterior portion. In annelids living in tubes the head has a great crown of tentacles, often beautifully feathered. The breathing apparatus are very large gills upon the head; but all the posterior part of the body has no gills upon it at all—lacks the organs of the free-swimming animal. This is the price that the animal has paid for its protection by a tube. In forming a tube to protect itself that part inclosed therein has lost all the unnecessary organs: there being no fresh current of water there the gills become useless and degenerate, and in many of these worms the hind part may change simply into a thin cord containing no important organs. The reason for the great head development in this crown of tentacles is, every animal either directly searches after its food itself or produces structures bringing the food to itself and holding it. The mouth of the animal is at the tip of the head in the midst of a crown of tentacles which surround it like open arms, reaching out, raking a very great surface; and any small food getting within reach immediately causes these tentacles to close—brings them down to the mouth; the use of the crown of tentacles being practically to increase the size of the mouth.

Another thing noticeable in animals which are sedentary is their tendency to become radial in structure. The jelly-fish's disk of a body shows a four-fold division of the gastro-vascular cavity. There are four radii in the animal. Our commoner star-fishes have five rays. All the star-fish's organs are arranged radially—not only the arms, but also in the nervous system, as a little circular brain around the mouth with five peripheral nerves going off from it; and its water vascular system is similarly arranged. This is a strict radiality, produced by the bottom life.

Probably the ancestors of these star-fishes were symmetrically bilateral like a worm; that is, the animal was elongated in one direction with a right and a left side. The larval free-swimming stages of the star-fish are bilateral. Since we know the young stages of these forms are free-swimming, their ancestors may have been. The star-fishes are forms which live a nearly sedentary life on the bottom, moving about only very little. Wherever we find sedentary animals, particularly animals that are fixed to one point immovably, we notice the tendency to change bilaterality to radiality; that is, the radial type of structure would not be the primitive type, but would be a secondary, degenerate type of structure, caused, we know not just how, by the animal's attachment to the bottom and its inability of movement.

The main thing in strand life is the great abundance of food and the very hard physical struggle for existence. The animals must attach themselves very firmly to the rocks in order to avoid being carried away by the tides, as in the rock barnacles and the corals.

In all the mollusks the greater lower portion of the body is prolonged into a very large foot with which it creeps. The snails, living on the strand just between the tides where the pressure of the waves is strongest to drag them away from their position, are the very ones with the broadest foot surface, the action of this foot pressing down on the rock by air suction holding the snail firm.

You may have noticed on these snails a second little shell (operculum) just on the upper side of the foot, like a little flat plate or disk. When the low tide comes on and the animal is left high and dry, it will draw its whole foot and head into its shell; finally, when the foot is withdrawn entirely, what we see is the foot withdrawn into the shell and bent around, so that the operculum fits in snugly and closes up the opening of the shell. This operculum is developed by reason of the animal's living between the tides, and it serves for the prevention of evaporation.

One of the most marked differences between land animals and those of the sea or fresh water is in the mode of breathing. In all animals living in the water the principle of breathing is to take in water and therefrom extract the oxygen, which is done by what are known as gills; that is, external breathing appendages. Land animals always have an internal breathing apparatus developed for this reason: the breathing cells of the body in order to take in food have to be kept moist—accomplished in marine animals by the surrounding sea water; but in the land ones, if there should be gills from the body extending into the air the air would dry them, and no oxygen can be taken up by a dry solid surface. So, instead of an external we have an internal apparatus developed, in which the whole surface can be kept moist and which we know as lungs. Thus a very important functional organ is changed entirely as between the land and the water animal.

Another difference is in the organs of locomotion. In marine animals the specific gravity is very much less than on land, so that many are just as light as water and their only action is simply to push themselves forward. On the land the animal is very much heavier than the air, and it must have organs developed for its support: hence, limbs. While these are developing it is open to the danger of evaporation in the air and to the very great dangers from enemies. That evaporation is counterbalanced in one or two ways. Some animals have a very glandular surface on the skin secreting a great amount of slime which keeps them moist all the time, as in the salamanders: or else there is (and this in most land animals) a thick outer skeleton, developed as a protection primarily against not enemies but evaporation in the air. If an insect's skeleton were immovable or unjointed, the animal would not be able to move at all; so there is developed an articulation—a jointing of the skeleton. The organs of locomotion become jointed also, and this only in land animals. Accordingly, the finding in any geological deposits of even a portion of a jointed limb would indicate with great probability that either the animal possessing it was a land animal or its ancestors were, because there is no reason apparently for a jointed limb to develop in a marine animal. The most primitive fishes that we know have the skeleton external. In fishes like the sturgeon there are no bones; in fact, no hard internal skeleton. There is what is known as the *notochord*, a cartilage rod running down the middle line of the back; surrounding the body of the animal is an external skeleton. Fishes a little higher in the scale of development show the external skeleton—a little bit thinner, less heavy—and show the beginning of an internal skeleton. That is, around the *notochord* vertebræ develop, and at its anterior end the bones of the skull arise. While the internal skeleton progresses the external gradually regresses. The internal being enough for the support of the animal, there is no need for the external; and by the added facilities of locomotion given to the animal through its internal skeleton there is no need for the external simply as a protection; for by its articulation of limbs and internal skeleton it can escape its enemies by its own activity. In the higher animals like the mammals or lizards, or the higher boney fishes like the shad, the main remnant left of the original outside skeleton is the teeth. That seems rather a strange statement to make, but in most primitive fishes that we know the whole surface of the skin is covered with hard, enamel-like plates and there is no hard internal skeleton. Among fishes a little higher developed the external skeleton covers the mouth, the lip region and the whole surface of the pharynx. Then come a little later in the scale of development the forms that are forming a hard, internal skeleton; and the result here is that with the use of the internal one the external skeleton disappears, except that it is retained in the mouth region, because in the mouth it is important to act as a masticating apparatus; and so from that original old skeleton that was once just on the outside of the body, serving only as a protection against enemies, there persists after all the rest has disappeared a remnant to function as teeth. The tooth that we know to-day is the only part of the old, external skeleton in the higher animals; elsewhere the internal skeleton has taken its place.

We find everywhere, if not always a perfect, as nearly as possible a perfect adaptation of the animal to the place in which it lives; we would never find, for instance, a free-swimming animal on the land and we cannot find an animal with a heavy, external jointed skeleton living on the surface of the sea; and if in a museum we see an animal that is uncommon—unknown to us—we can say by the nature of its structure just where that animal lives. It is the same thing as in the case of the old comparative anatomists taking up a single bone, a tooth or a single vertebra, and from that bone being able to say what the rest of the animal is like. It is just the question of arguing by analogy, and not soothsaying; we happen to know that certain groups of animals have certain kinds of vertebræ and that a vertebra being found of a certain structure—no matter whether or not we find any other bones of the animal—we can say that vertebra occurring here necessitates other vertebræ somewhere else like it and that animal must have had a certain form of structure. If any one takes the trouble to look at the animals and see how they are accustomed to their environments and how well adapted they are to them, he cannot fail to be struck with the thought that that adaptation may not have been made by a special creation of every animal to its environment in the original instance, but it must have been reached, as we see it to-day, by a gradual and continually changing series of adaptations by which the animal adapts itself to its environment. If the environment changes, the animal which is not able to adapt itself to the change must die.

THE STRONGHOLD OF THE NUTHATCH.

A STORY OF SIEGE AND DEFENSE.

By A. H. MACHELL COX, M.A.

PICTURE a sleepy old rectory garden—a very paradise of birds—merging into a little rambling spinney, and lying so close beneath its shelter that the gradual, almost imperceptible, transition only serves to enhance the sweet smell of the woodland. Here and there a fine oak breaks the stiffness of surrounding evergreens. One such tree is so persistently visited all the year round by a pair of nuthatches as to arouse in the practised bird-nester a suspicion which a closer scrutiny proves to be well founded. At a height of rather more than thirty feet from the ground is a hole, clearly enough the socket of a branch long since defunct, and only arresting attention by its unnaturally smooth and rounded appearance. For such an eligible building site as this there must have been at one time applicants in plenty among the various birds that seek a habitation in ready-made cavities, but in the end our nuthatches evidently obtained the premises on a long lease, and for many a year (with one notable exception, to which I shall presently refer) their tenancy has remained undisputed. Nor is the reason far to seek. Against birds no larger than itself the sturdily built nuthatch, with its strong, formidable bill, is perfectly capable of holding its own, while against more determined aggressors like starlings it adopts the ingenious precaution of plastering up the entrance to its home with mud, and reducing it to such a size as will exactly meet its own requirements. This is a well-known peculiarity; that it forms an invariable feature of the household arrangement cannot indeed be positively asserted, but from all accounts the exceptions to the rule must be very few indeed. Similarly it is recorded that before a nuthatch can be induced to take possession of a nesting box in a garden, its habitual cuteness leads it to detect the lid opening on a hinge, so fatal to privacy, a drawback which it will at once proceed to remedy by a plentiful application of clay. So skillfully is the work done in the first instance, that when the nesting season comes around again, only slight repairs and alterations are required; but these receive the most scrupulous attention, and even in the depth of winter an occasional inspection is made, and these all important defenses overhauled. I do not recollect ever having seen the male nuthatch assist his mate in any of the actual work, but he is invariably somewhere at hand in close attendance, and ever ready in the spring to serenade her with his cheery long-drawn whistle; in the winter he is perhaps apt to be self-assertive, but during the time of courtship I have watched him offering, with an air of the greatest gallantry, choice morsels of food to his mistress.

Immunity from danger had, as I have said, been long enjoyed by this particular pair, and it was with some compunction that I yielded at last to my instincts as a bird-nester, and resolved to exact the toll that seemed so ready to my hand. Had I indeed anticipated that any disastrous consequences might attend my raid I should certainly have abandoned the idea; but I argued from what I knew of their general disposition that there would be little likelihood of their home being deserted for any cause short of deliberate eviction. Accordingly at the time when I calculated that the eggs should have been laid, I secured a ladder (without the aid of which the hole was inaccessible), and armed with chisel and hammer ascended to commit the burglary. My intention was to enlarge the entrance sufficiently to enable me to insert a hand and investigate the interior; but I soon found that I had underrated the difficulty of such a task. The wood was extraordinarily hard, and the mud defenses themselves could hardly have been removed without tools; moreover, the distracted owners, taking up positions within a few yards of me, never ceased to protest loudly and vigorously, and altogether showed such keen distress that I was more than once half inclined to desist. When, after two hours' hard work, the nest was brought within reach and proved to be empty, it almost seemed like a judgment on persecution. It only remained for me to do all in my power to repair the damage done, and some wet clay soon enabled me to reduce the hole to its original dimensions. Hardly had I descended to the ground when a blue tit appeared on the scene, and, perching for a moment on a rung of the ladder poked his head into the hole with characteristic curiosity. A few moments later, to my great satisfaction, I witnessed the return of the rightful occupants, who without further ado proceeded to complete my amateur work as a plasterer. So ended the first act of the drama; reference to my notebook shows that the date was April 17.

For just a week the nest was left undisturbed, and then I made a second investigation. During the respite the rude clay had by some mysterious process, the secret of which the nuthatch seems to share with swallows and house martins, been hardened to the consistency of cement, the whole surface having been so scored all over by countless indentations of their beaks that it presented the appearance of elaborate stucco work. This time it was only the work of a minute to make a breach, and the results, though not altogether successful, were on the whole satisfactory. A single egg was discovered in the nest; this I carefully replaced and a fresh supply of clay was utilized for the needful repairs. Once more the birds returned undaunted.

Now a fresh complication arose which quite altered the aspect of affairs. The next morning I was approaching the tree quietly to see how things were going on, when I caught sight of a bird, which proved to be a starling, busily pecking away at the entrance to the hole. The fact was that all the starlings in the neighborhood were just then turning their thoughts to the business of nesting, and the sharp eyes of one pair had already discovered that this hitherto impregnable position had been tampered with, and that the clay, while still damp and soft, presented no insuperable barrier. Possibly they had witnessed the whole proceedings of the previous day and laid their plans accordingly. However that might be, I determined to defeat their object. Fetching my gun I cautiously stationed myself in hiding among the bushes beneath. I had not long to wait. A starling settled noisily on the top branch and was at once joined by another. There they commanded the situation, and their purpose was unmistakable; as I wished, however, to catch them *in flagrante delicto*, I still awaited developments. Presently first one and then the other nuthatch returned for a moment to the tree, but scenting danger flew off again uneasily. An interval ensued during which the conspirators (myself included) remained motionless at their several posts, and then the female came back with a large bit of clay in her beak, and after flying round the tree once or twice alighted on the trunk on the side sheltered from the view of the starlings. Gliding quickly down she suddenly slipped round to the hole, and was beginning hastily to attend to repairs, when one of the starlings with a harsh chattering noise swooped viciously down upon her. In less time than it takes to write the other nuthatch had come to the rescue, only to find the attack reinforced by the second starling. Taken at a disadvantage the nuthatches had to beat a retreat, and the original starling—the principal aggressor—stood screaming triumphantly at the mouth of the hole. At that instant I fired, and it dropped dead; on examination I was interested to find that it was a female. Once more the nuthatches gave a striking example of their intrepidity, for the report of the shot had hardly died away when they were both back at the tree, resuming operations with as much apparent unconcern as if nothing at all had happened. I mounted guard a little longer and presently shot another starling on the tree, and by way of enforcing the lesson hung its body up within a few feet of the hole. Knowing, however, the pertinacity of these birds, I did not feel too sanguine even then that the mischief would go no further.

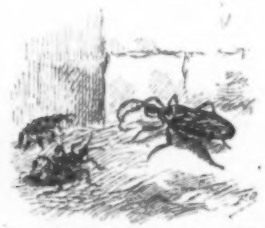
On the following day, when I went into the garden before breakfast, the first thing that met my eye was a nuthatch on the path in front of me where it was busily picking up mud. This it did by carefully detaching and rolling together a pellet about the size of a shilling, with which it flew straight to the hole. A single glance at the latter more than confirmed my misgivings. The starlings had not only removed every trace of the protecting clay, but had actually ejected the egg from the nest; the broken shell lay on the ground beneath. Undeterred by the grim scarecrow before them a number of these marauders had gathered on the scene and were apparently actively disputing the possession of so desirable a building site. Desperate but determined as ever, the nuthatches used most strenuous efforts to get the gaping hole plastered up afresh. But against such odds their present task was about as profitable as pouring water into a sieve, and it was only too obvious what the end must be. At this critical moment I hit on a plan by which I was able to befriend them to some purpose and make amends for the injury they had previously suffered at my hands. It was simple but effective. With the aid of a hammer and nails, I fastened a bit of wood securely over the hole in such a way as to leave it just large enough for the nuthatches; this was a rather unsightly makeshift, but a further application of clay served both to conceal the deficiencies in this respect and to restore the original character of the threshold. While this work was going forward, both nuthatches stood on the tree close beside me, and no longer uttered the notes of alarm which had been so incessant before. They lost no time in testing the result when I descended the ladder, and it was a comical sight to see the female's frantic contortions in squeezing through the hole, which was now inconveniently small. This, however, was clearly a fault on the right side, and the nuthatches were after all left in possession of the field. The starlings were sensible enough to acknowledge defeat, but before doing so one individual (possibly the survivor of the original pair) planted himself at the mouth of the hole, and, thrusting in his head as far as possible, railed at the dauntless little inmate in unmistakable Billingsgate. Then he like the others decided to raise the siege, and peace reigned once more.

A whole fortnight passed, and the nuthatches toiled indefatigably to make good their own defenses behind the improvised shelter which they evidently considered insufficient; certainly their previous experience might well justfy misgivings as to my present *bona fides* in affording them protection. Eventually the traces of their labors could be seen extending inward to a depth of more than six inches. During this period I observed that they generally repaired to one particular spot on the path in order to fetch their supply of mud, coming and going with such singular directness that, when one day I had inadvertently placed myself where I interrupted the traffic, I was startled to see the busy little worker pass and repass within a foot of my head with an absolute disregard of my presence. A well-known writer has indeed suggested from close observation of a tame nuthatch that these birds are peculiarly short sighted; and while the action I have mentioned does not necessarily support such a theory (which indeed it is hard to accept without further evidence), it has a certain interest as bearing on the question.

It is satisfactory to be able to record that this pair of plucky birds eventually brought off their brood triumphantly after all their persecution, and appear likely to enjoy for a long time to come the security that they have done so much to earn.

ANIMALS THAT CLOTHE THEMSELVES.

MAN dresses especially in order to protect himself against the inclemencies of the weather. Certain animals also clothe themselves, but in order to escape



LARVÆ AND ADULT OF REDUVIUS PERSONATUS.

their enemies or to approach their prey without being perceived. It is not necessary to go very far to find examples of them. Thus, in our houses, especially in dark corners and in garrets, we meet with the larva of the *Reduvius personatus*, an insect that clothes itself in a somewhat summary manner by rolling itself in the dust. It thus resembles a ball of dirt, and,

A LARVA OF CLOTHES MOTH SUSPENDED BY ITS CASE. *B.* CHRYSALIS. *C.* MOTH.

owing to such disguise, is capable, without being seen, of approaching the insects upon which it feeds, such as flies and bedbugs. Coming within reach of its victim, it jumps upon it and pierces it with its sting.

We may also see an analogous and still more interesting example in our gardens. We refer to the caterpillars of the moths belonging to the genus *Psyche*, which construct very curious cases. These latter, which are open at the ends, are lined with silk and covered with bits of plants or minerals. The materials in most instances consist of pieces of straw arranged longitudinally or transversely, and mixed with particles of stalks, leaves or mosses. Sometimes the case is simply covered with dust or gravel. The general form of it is conical or cylindrical. One of the species (*Psyche helix*) lives in a case of grains of sand arranged in the form of a snail shell. When, as

CATERPILLARS AND MOTH OF GRAMINACEOUS PSYCHE.

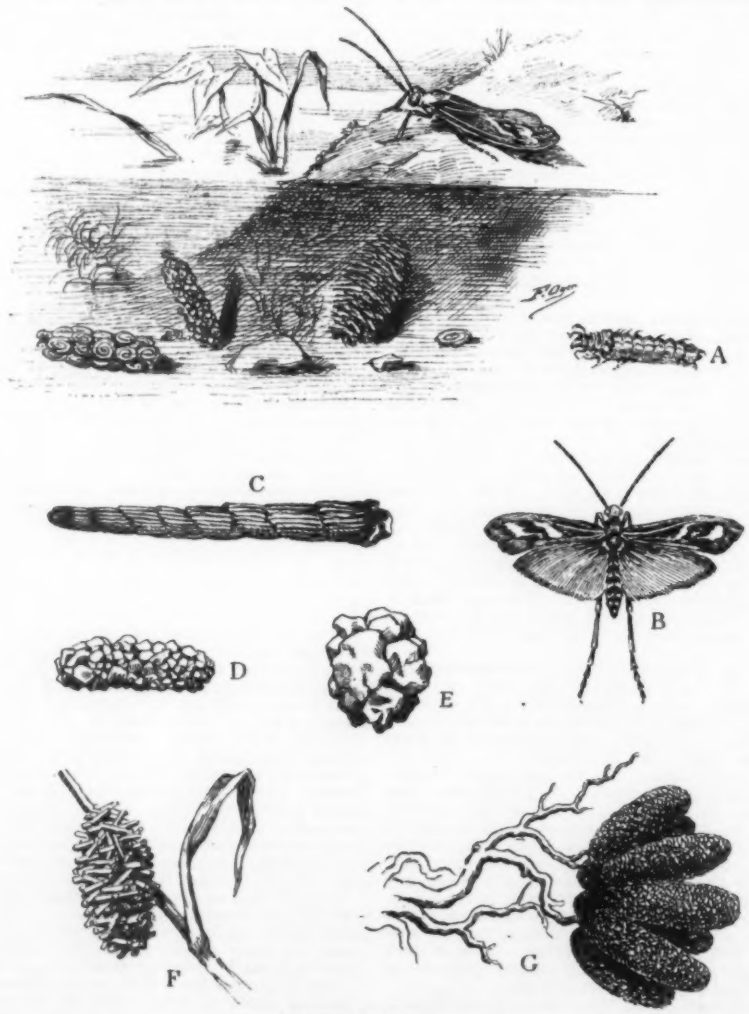
in *Psyche quadrangularis*, the case is formed of twigs placed parallel with the axis, it closely resembles an elegant little basket. When these caterpillars are moving among low plants or upon a wall, it is almost impossible to distinguish them, and small birds, their deadly enemies, pass them by without perceiving them.

The females of the *Psyches* are not winged like the males, and have rudimentary feet. They live in cases that have been left to them by the caterpillars from which they are descended, and therein lay their eggs. The young caterpillars that result therefrom devour the remains of their mother's body, and fraternally divide the pieces of the case in order to construct proper coverings for themselves.

One of the animals that best knows how to clothe itself is the common clothes moth. Reaumur has left a certain number of observations upon the manner in which it constructs its case, and from these we shall quote. The larva of this moth is a naked-bodied worm which, in order to protect itself, manufactures a case which it carries everywhere with it. The entire exterior of this case is a sort of woolen fabric, sometimes blue, sometimes green, sometimes red, according to the material to which the animal has attached itself and used for its purposes. The exterior alone of the case

MOTH UPON A PIECE OF CLOTH.

is of wool, the interior being of silk. When the insect wishes to elongate its case, it sticks its head out of one of the ends and rapidly moves it to the right and left in search of the most proper threads of wool. If the threads within its reach do not suit it, it sometimes projects more than half of its body out of the case in order to find a better place farther off. When it finds a thread that it likes, it seizes it with two teeth with which it is provided, under the head near the mouth, and, having detached it, fixes it to the extremity of its case. After it has worked for a few seconds at one of the ends of the latter, it turns around in the interior and proceeds to work at the other



PHRYGANEIDS.

A. Larva outside of its case. *B.* Adult with wings extended. *C, D, E, F, G.* Different forms of cases.

extremity. It is remarkable to see how quickly this turning about in so small a space is effected.

While the insect is growing longer it is also increasing in thickness, and consequently its covering becomes too small for it; but it does not on that account abandon it as some insects would do. On the contrary, it goes to work to enlarge its quarters. It was thought at first that the efforts made by the body against the side of the case in bending distended the tissue and caused the hairs to slide over one another and thus produced an enlargement. But various observations showed Reaumur that the enlargement of the case was not the effect of chance or a sort of necessity. He put some moths whose cases were of a single color upon fabrics of a different color—caterpillars with a blue case upon red, and other with a red case upon green, etc. After a short time he observed that the cases were elongated and widened. Just as circular bands made of hairs of the new material that had been supplied to the insect showed the elongation of each end, so also bands that extended in a straight line from one extremity to the other showed the widening that had occurred. These bands, two in number, were parallel with each other, and nearly equidistant above and beneath the case.

It remained to know how the insects managed to make such enlargements along each side of their case. By dint of observation Reaumur found that the method that they employ is precisely that to which we would have recourse under the same circumstances. In order to widen too narrow a sheath made of wool, it would immediately occur to us to split it lengthwise and insert a strip of the proper size between the separated parts. If the fôrm of the sheath required it, such a piece would be inserted on each side. This is precisely what is done by the caterpillar, which furthermore takes precautions against having its body exposed while at work. Instead of two pieces extending from one end of the case to the other, it uses two that are but half the length, and so never forms a fissure in more than half the extent of its habitation at a time. The process of lining the case with silk may be imagined when we state that the caterpillar of the clothes moth, like others, is a spinner. The thread passes out just beneath the head. It is so slender that it is difficult to perceive it without a good microscope, but is nevertheless strong enough to hold the insect suspended. It is with this thread that the caterpillar binds together the different fibers of wool that compose the case, so that the texture of the upper part may be compared to a fabric with a wool warp and a silk woof. It is a singular thing that if the caterpillar of the clothes moth be removed from its case it does not try to re-enter it, but prefers to make another.

It is not only among terrestrial animals that such things are met with. Everyone who has visited the seashore knows the sea-spiders, those great spiny crabs provided with long legs. By the aid of their claws these animals place algæ, polyps, bryozoans, etc., upon their shell, so that their entire body is soon converted into a genuine zoological museum and botanical garden. The crab disappears under a growth of seaweeds that renders it unrecognizable. Some naturalist or other took it into his head to remove the algæ from one of these crabs and put rose petals within its reach. The animal seized these and placed them upon its shell, and was soon entirely covered with a garment that would have made many a fair opera-goer envious.

Let us mention also the larvæ of the *Phryganeids*, which manufacture a protecting case with different materials—a nest that they enter at the least alarm and that certain species carry about with them. These cases permit them to wander among herbs without being perceived. The materials vary according to the species. Sometimes they are stones, sometimes sand, and sometimes pieces of plants all of the same length arranged in parallel and in a regular spiral. Moreover, the *Phryganeids* are capable of varying the covering of their cases according to the materials that are placed at their disposal. The larva, before changing into a chrysalis, attaches its case to a plant or stone, and sometimes to another case by means of a silken thread, and places it obliquely so that the water can be renewed with more facility.—For the above particulars and the engravings we are indebted to Le Monde Moderne.

SYNTONIC WIRELESS TELEGRAPHY.

By GUGLIELMO MARCONI.

THE very rapid advances which have been made in the art of telegraphy through space continue to attract much attention to this fascinating subject. What was stated yesterday to be impossible has now become possible, and what we regard as almost insurmountable difficulties may be removed in the immediate future.

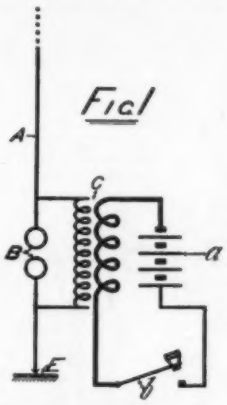
The number of experimenters working in this field has increased, as many workers who some time ago had little or no faith in the practical utility of wireless telegraphy have now changed their minds and are taking up the subject.

I believe it to be necessary before I proceed to deal with the subject to state that in my opinion a large amount of inaccurate and misleading information is being from time to time published upon it in the daily and even in the scientific press. I shall endeavor to correct some of the misstatements which have been made.

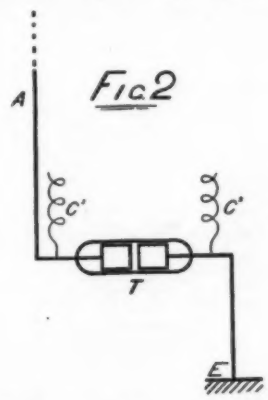
As the title of my paper implies, it is my intention first to describe fully the efforts I have made in order to tune or syntonize the wireless system, efforts which I am glad to say have been crowned with complete success.

I also wish to mention something of the difficulties encountered in promptly publishing the results (whether successful or otherwise) obtained in the course of my experiments. A commercial concern, such as the one with which I am working, does not exist solely for the advancement of science, but especially for the purpose of securing a pecuniary return to those who have braved risks and undertaken sacrifices in assisting and forwarding the necessary experimental work.

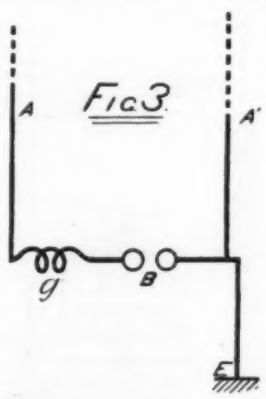
It is often considered possible that certain new methods and results may, if prematurely published before being fully patented, be utilized by persons whom I might call business rivals, thus preventing those who have borne the initial cost of the first tests from benefiting in a fair measure. I am therefore frequently prevented from promptly publishing the methods by which I have obtained interesting results. By quoting the dates of the British patent specifications and other publications, I hope to be able to establish, to a certain extent, the dates at which the various systems or methods were worked out. It may probably surprise some of you when I mention how comparatively long ago some of the patents which I shall discuss tonight were applied for and perfected.



Last winter I had the honor of describing before the Royal Institution of Great Britain most of the success obtained up to that date in communicating by means of my system from one place to another. It is my desire in this paper to give a description of the further progress made, with special reference to the results obtained by tuning or syntonizing the installations. So long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilization of the system was imposed. With simple vertical wires, as shown in Fig. 1 A and Fig. 2, connected directly to the coherer and spark gap at the receiver and transmitter, as used by myself before 1898, no really satisfactory tuning was possible. It was, however, possible to obtain a certain selection of signals if various stations in the vicinity used vertical wires differing very considerably in length. Thus two stations communicating over a distance of say five miles and using wires 100 feet long, would not interfere with the signals transmitted by the other two stations, say two miles from the first, which were using aerials only 20 feet long and communicating over a distance of about one mile.



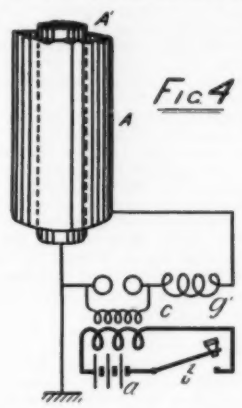
The new methods of connection which I adopted in 1898—i. e. (see Fig. 8), connecting the receiving aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser so as to form a resonator tuned to respond best to waves given out by a given length of aerial wire—were important steps in the right direction.



I referred extensively to this improvement in the discourse delivered before the Royal Institution on February 2, 1900, and my first British patent specification referring thereto was applied for on June 1, 1898, No. 12,326, and published in due course. This mode of connection was also discussed by the technical press.*

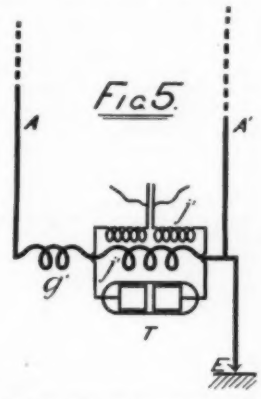
It is remarkable that eminent scientists and engineers, such as Prof. Slaby and G. Kapp, who have been good enough to discuss my work on "Wireless Telegraphy," should be so badly informed on the subject in general as not to know that this method and many other improvements on my original system have been in use by myself and my assistants for several years.

I wish to give you an illustration of what I mean. In a paper on "Tuned or Multiple Wireless Telegraphy" by Prof. Slaby, of Charlottenburg, read on December 22, 1900, and published in a special number of the Elektrotechnische Zeitschrift, he stated: "Up to the present the following method has been followed without exception. The receiving wire was *suspended insulated and attached at the lower end to the coherer*, the other pole of which was connected to earth."

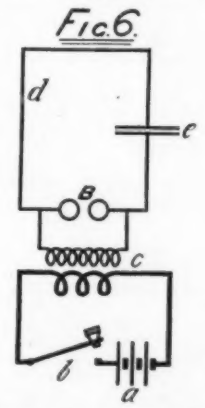


Again, G. Kapp, in an editorial review in the same publication, states: "According to the Slaby d'Arco system and *in opposition to the Marconi system, the receiving wire is earthed.*"

The inaccuracy of these statements is very apparent if we compare them with the description given by myself nearly three years previously in the British patent applied for, as I have remarked, on June 1, 1898, published in July, 1899, and openly discussed by the scientific press of this and other countries a long time previous to the date of Slaby's paper. At line 7, page 1, of my description, will be found the following passage. "According to this invention, the conductor (aerial) *is no longer insulated, but is connected to earth* through the primary of an induction coil, while the ends of the imperfect contact (or coherer) are connected to the ends of the secondary one of the connections passing through a condenser."



As you will notice, nothing is said in this patent of the necessity of insulating the vertical wire of the receiver. If the system described here had not been used by me, I very much doubt whether we should have succeeded in maintaining communication with the East Goodwin lightship during 1899, in maintaining communication across the English Channel that same year during the meeting of the British Association at Dover, and in supplying the Admiralty in the course of the year 1900 with 32 installations, all which passed an official 100-kilometer test (most of the distance being over land), at the rate of about three installations per week.



Leaving this subject for the present, I shall endeavor to describe the various steps made in the development of my syntonic system. I realized a long time ago that one great difficulty in achieving the desired effect was caused by the action of the transmitting wire. A simple straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves. If this was in the beginning an advantage, by allowing signals to be received with

* See the Electrician, vol. xliii., p. 48; also vol. xliv., p. 555-556.

a small amount of energy over considerable distances, it proved later to be one of the chief obstacles in the way of obtaining good resonance in the receiver. Now, as Dr. Fleming points out so clearly in his Cantor lectures on "Electrical Oscillations and Electric Waves," delivered before this society in November and December of last year, there is in connection with this part of the subject one point of great interest. "Both theoretical and experimental research show that in the case of conductors of a certain form the electric oscillations die away with great rapidity." In all what we call good radiators, electrical oscillations set up by the ordinary spark discharge method cease, or are damped out very rapidly, not necessarily by resistance, but by electrical radiation removing the energy in the form of electric waves.

Many mechanical analogies can be quoted which will point out the necessity of designing a persistent oscillator, in order that syntony may become apparent in properly tuned resonators. Acoustics furnish us with numerous examples of this fact, such as the resonance effects produced by the well-known tuning-fork experiment. Other illustrations of this principle may be given, e. g., if we have to set in motion a heavy pendulum by means of small thrusts or impulses, these must be timed to the period of oscillation of the pendulum, since otherwise its oscillations will not acquire any perceptible amplitude. An illustration of this fact occurred to me some time ago while I was watching the ringing of great bells in an Italian cathedral. As most of you probably know, the bells in many churches in Italy, as elsewhere, are rung from the bottom of the tower by means of ropes attached to the bells. The largest bells weigh several tons, and it usually requires two men to work for perhaps two minutes on the ropes before the combined effect of their pulls is sufficient to get the bell to attain an amplitude large enough to cause the hammers to strike. I observed on the occasion to which I allude that it required for each bell a number of well-timed pulls on the ropes in order to get them to swing, the larger bells requiring impulses further apart—i. e., of a lower frequency—than the smaller ones. It is perfectly obvious that if the pulls on the ropes had been wrongly timed it would have been impossible, with the same amount of power, to ring the bells. The same kind of effect happens in a very small fraction of a second (instead of several minutes) when we try to induce electrical oscillations in a good resonator. If the form of this resonator be such as to cause it to be a persistent vibrator—i. e., one in which the electrical oscillations are not rapidly damped by resistance or radiation of waves—then it is necessary for us to employ a number of properly timed electrical oscillations radiated from a persistent oscillator tuned to the period of the resonator we desire to affect.

As I pointed out before, a transmitter consisting of a vertical conductor as shown in Fig. 1 is not a very persistent oscillator. Its electrical capacity is comparatively so small and its capability of radiating waves so great, that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it. From the results obtained it would seem as if the transmitter were sending out a great variety of electric waves, resembling therefore a source of white light, and that each resonator picks out and responds to its own particular wave length.

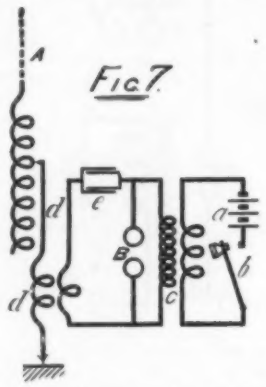
This view, however, is incorrect; the fact that, given certain conditions, various resonators will respond, even if their period be different from the natural period of oscillation of a transmitter, is to be accounted for by the consideration that all the energy of the transmitter is radiated in only one or two swings, with the result that oscillations may be induced in resonators of different periods, while, if the same amount of energy be distributed in a great number of individual feeble impulses, their combined effect can only be utilized or detected by a resonator tuned so as to respond to their particular frequency. The tuned resonator will not then respond to the first two or three oscillations but only to a longer succession of properly timed impulses, so that only after an accumulation of several swings the E.M.F. becomes sufficient to break down the insulation of the coherer and cause a signal to be recorded.

Notwithstanding the disadvantages for obtaining electrical tuning, attributed to the form of transmitter shown in Fig. 1, selection of messages is possible when using, say, two or three transmitters having wires of considerably different lengths, and the induction coil or oscillation transformers on the receivers wound with varying lengths of wire in their secondary circuits, in order to cause them to be in tune or resonance with the length of wave of the transmitted oscillations as pointed out in my British patent, No. 12,326, dated June 1, 1898. At page 1, line 19, this reads: "It is desirable that the induction coil should be in tune or syntony with the electrical oscillations transmitted, the most appropriate number of turns and most appropriate thickness of wire varying with the length of wave transmitted."

The following experiment which has been successfully tried proves this point. At St. Catherine's, Isle of Wight, we had a transmitting station having a vertical wire 45 meters long, and at sea, 10 miles from our receiving station at Poole, a ship with transmitting wire of 27 meters. It is therefore obvious that the wave length of the electric oscillations radiated from St. Catherine's differed considerably from that radiated from the ship. Now, if at the receiving station at Poole we connected to a vertical wire two receivers, one having an induction coil with secondary in tune with the length of wave emitted by St. Catherine's and the other with that emitted by the 27-meter feed wire on the ship, if St. Catherine's and the ship transmit simultaneously two different messages, these will be picked up at Poole, and each message will be reproduced distinctly on its receiver.

I pointed out in a patent specification dated December 19, 1899, No. 25,185, page 2, that the best results are obtained when the length of wire of the secondary of the induction coils is equal to the length of the vertical wire used at the transmitting station; therefore the length of the secondary of the receiving induction coils was made equal to that of the transmitting wire. (Something of the same kind has been lately noticed by Prof. Slaby in what he calls an extension wire.)

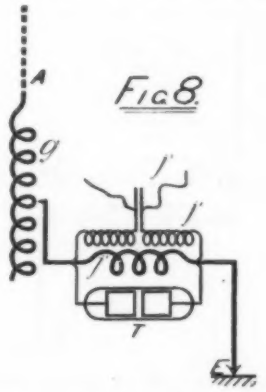
These results, although in a way satisfactory, did not appear to my mind a complete solution of the problem. I found it impossible to obtain the two messages at the receiving station, if the two transmitting stations were placed at equal distances from it. The following considerations may perhaps explain this failure. If the 27-meter transmitting wire was placed at the same distance from Poole as the 45-meter one—i. e., 31 miles—the waves emitted by the 27-meter wire would be too weak when they reached Poole to affect



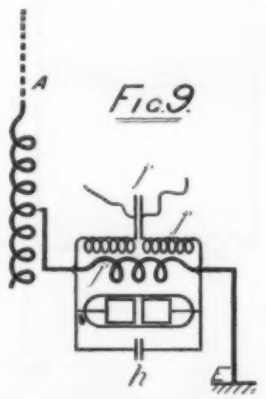
the receiver. On the other hand, if the 45-meter transmitter was placed at 10 miles from the receiver, then the waves radiated by it would be so strong as to affect the receiver tuned to respond to the 27-meter transmitter, and blur its signals.

It thus became apparent that some different form of less damped radiator was necessary, in order to obtain more practical and more useful results.

I carried out a great number of experiments by adding to the radiating and receiving wires inductance coil, on a principle similar to that suggested by Lodge in his 1898 patent (No. 29,069), but without obtaining any satisfactory results. The failure was probably due to the fact that the electrical capacity of the exposed conductors became too small in proportion to



their inductance. I then tried various methods for increasing the capacity of the radiating system. The first and obvious mode of effecting this is by an augmentation in the size of the exposed conductor, but this method is not entirely satisfactory, in consequence of the circumstance that an increased surface means increased facility for radiating the energy during the first oscillations, and also because large plates or large exposed areas are impracticable on board ship, and are always difficult to suspend and maintain in good position during windy weather. The way out of the difficulty was discovered by adopting the arrangement shown in Fig. 3. Here we have an ordinary vertical radiator placed near an earthed conductor, the effect of the adjacent conductor being obviously to increase



the capacity of the electrical radiating wire without in any way increasing its radiative power, and, as I had expected, syntonic results were not difficult to obtain with such an arrangement. Mention of this method has been made by Captain Ferrie, one of the members of the French Commission which was present at the tests carried out across the English Channel in 1899, in a paper on wireless telegraphy. See paper "Etat Actuel et Progrès de la Telegraphie Sans Fil," read before the Congrès International d'Electricité, Paris, 1900.*

* See The Electrician, October 26, 1900, page 22.

Satisfactory results were obtained, and I was encouraged to continue my researches in order to improve the system.

Early in 1900 I obtained very good results with the arrangement shown in Fig. 4. This arrangement is fully described in a British patent application applied for by myself on March 21, 1900, No. 5,387. In it the radiating and resonating conductors take the form of a cylinder, the earthed conductor being placed inside. This form of radiating and receiving areas is much more efficient than the one I have previously described. One necessary condition of this system is that the inductance of the two conductors should be unequal, it being preferable that the large inductance should be joined to the non-earthed conductor. I presume that in order to radiate the necessary amount of energy, it is essential that there should be a difference in phase of the oscillations in the two conductors, as otherwise their mutual effect would be to neutralize that of each other. In the first experiments mentioned by Capt. Ferrie, this was obtained by simply using an earthed conductor shorter than the radiating or resonating one. When I used an inductance between the spark gap or oscillation producer and the radiating conductor, I found it possible to cause the electrical period of oscillation of the receiving cylinder to correspond to that of one out of several transmitting stations, from which one alone it would receive signals. The results obtained by this system have been remarkable. By using cylinders of zinc only 7 meters high and 1.5 meters in diameter, good signals could easily be obtained between St. Catherine's, Isle of Wight, and Poole (distance 31 miles), these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the Admiralty in the immediate vicinity. The closely adjacent plates and large capacity of the receiver cause it to be a resonator possessing a very decided period of its own—i. e., it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves which are sometimes probably caused by atmospheric disturbances, and which occasionally prove troublesome during the summer.

It seemed very remarkable to me during my first test that an arrangement similar to that shown in Fig. 4 should prove to be a good radiator, and should enable such a considerable distance to be achieved with cylinders of so moderate a height. It is probable that the great majority of the electrostatic lines of force pass directly from one cylinder to the other, but it must be also true that a certain number leave the outer part of the external cylinder, exactly as in the case of an ordinary radiator.

The receiver is not shown in the sketch, but consists of similar cylinders to those used for transmitting the receiving induction coil or oscillation transformer, being placed where the spark gap is shown in Fig. 4.

The capacity of the radiator due to the internal conductor is, however, comparatively so large that the energy set in motion by the spark discharge cannot all radiate in one or two oscillations, but forms a train of slowly damped oscillations, which is just what is required. A simple vertical wire, as shown in Fig. 1, may be compared with a hollow sphere of thin metal, which, when heated, would cool very rapidly, and the concentric cylinder system with a solid metal sphere, which would take a longer time to cool.

Mr. W. G. Brown suggested, in a patent specification dated July 13, 1899, No. 14,449, the use of two conductors of equal length joined to each side of the spark gap, but he did not describe the inductance in series between them and the spark gap, which, according to my experience, is absolutely essential for long distance work.

Another very successful syntonized transmitter and receiver system was the outcome of a series of experiments carried out with the discharge of Leyden jar circuits. Taking for granted that the chief difficulty with the old system, as shown in Fig. 1, lies in the fact, as already stated, that the oscillations are very dead beat, I tried by means of associating with the radiator wire a condenser circuit, which was known to be a persistent oscillator, to set up a series of persistent oscillations in the transmitting vertical wire.

An arrangement as shown in Fig. 6, which consists of a circuit containing a condenser and spark gap, constitutes a very persistent oscillator. Prof. Lodge has shown us how, by placing it near another similar circuit, it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars.

But, as Lodge points out, "a closed circuit such as this is a feeble radiator and a feeble absorber, so that it is not adapted for action at a distance."* I very much doubt if it would be possible to affect an ordinary receiver at even a few hundred yards. It is very interesting to notice how easy it is to cause the energy contained in the circuits of this arrangement to radiate into space.

It is sufficient to place near one of its sides a straight metal rod or good electrical radiator; the only other condition necessary for long distance transmission is that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit.

Stronger effects of radiation are obtained if the radiating conductor is partly bent around the circuit including the condenser (so as to resemble the circuits of a transformer).

I first constructed an arrangement as shown in Fig. 14, which consists of a Leyden jar or condenser circuit in which is included the primary of what may be called a Tesla coil, the secondary of which is connected to the earth or aerial conductor. The idea of using a Tesla coil to produce the oscillations is not new. It was tried by the Post Office officials when experimenting with my system in 1898, and also suggested in a patent specification by Dr. Lodge, dated May 10, 1897, No. 11,575, and by Prof. Braun, in the specification of a patent dated January 26, 1899, No. 1,862. My idea was to associate with this compound radiator a receiver tuned to the frequency of the oscillations set up in the vertical wire by the condenser circuit. My first trials were not successful, in

* The Work of Hertz, by O. J. Lodge, page 7.

consequence of the fact that I had not recognized the necessity of attempting to tune to the same period of oscillation (or octaves) the two electrical circuits of the transmitting arrangement (these circuits being the circuit consisting of the condenser and primary of the Tesla coil or transformer, and the aerial conductor and secondary of the transformer).

Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver. The syntonized transmitter is shown in Fig. 7. The period of oscillation of the vertical conductor, *A*, can be increased by introducing turns, or decreased by diminishing their number, or by introducing a condenser in the series with it. The condenser, *C*, in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity. The receiving station arrangements are shown in Figs. 8 and 9.

Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I place an adjustable condenser across the coherer in Fig. 9. Now, in order to obtain the best results, it is necessary that the free period of electrical oscillations of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser.

I stated that in order to make the tuning more marked I placed a condenser across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble, but properly timed, electrical oscillations being received, the effect of the same is summed up until the E.M.F. at the terminals of the coherer is sufficient to break down its insulation and cause a signal to be recorded.

In order that the two systems, transmitter and receiver, should be in tune, it is necessary (if we assume the resistance to be very small or negligible) that the product of the capacity and inductance in all four circuits should be equal. A more complete and detailed description of this system is given in a British patent granted to me, dated April 26, 1900, No. 7,777. I have recently found that Prof. Braun has recognized the necessity of tuning the circuits of the transmitter and receiver when using a Tesla coil in order to obtain syntonic effects, but I am not aware that such a proposal was published prior to the description given in the above-mentioned patent.

Although little difficulty has been encountered in measuring the capacity used in the various circuits, the measurement or calculation of the value of the inductance is not so easy. I have found it impracticable, by any of the methods with which I am acquainted, directly to measure the inductance of, say, two or three small turns of wire. As for calculating the inductance of the secondary of small transformers, the mutual effect of the vicinity of the other circuits and the effects due to mutual induction greatly complicate the problem.

Experiments have confirmed the fact that the receiving induction coils having the secondary wound in one layer and at a certain distance, say two millimeters (to cause the capacity to be so small as to be negligible), have a time period approximately equal to that of a vertical conductor of equal length (see patent granted to G. Marconi, dated December 19, 1899, No. 25,186).

If, therefore, we are using an induction coil having a secondary 40 meters long on the receiver, I should use a vertical wire 40 meters long at both transmitting and receiving stations. By so doing I have the two circuits at the receiving station in tune with each other, and I only have to adjust the capacity of the condenser at the transmitter, which can easily be done, either by means of a condenser having movable plates that can be slid, more or less, over each other, or by adding or removing Leyden jars.

If we start with a very small capacity which we gradually increase, a value of the capacity will be reached, which will cause signals to be recorded on the receiver. Supposing the receiving system to be within the sphere of action of the transmitter, then the signals will be strongest when the capacity of the condenser is of a certain value. If we still increase the capacity, the signals will gradually die away, while if we go on increasing the capacity, and at the same time add inductance to the aerial, to keep it in tune with the condenser jar circuit, we are still radiating waves, but these do not affect the receiver. If, however, at the receiving station, we add inductance or capacity to the wire, *A*, Fig. 9, and also to the ends of the secondary *J* 2, we find ourselves able to receive messages from the transmitter, although we are utilizing waves of a different frequency.—Journal of the Society of Arts.

(To be continued.)

CONTEMPORARY ELECTRICAL SCIENCE.*

ESPERANTO.—The proposed international language called "Esperanto" has received recognition by the French Academy of Sciences to the extent of being made the subject of a paper by one of its members, H. Sebert, who writes "On the Scientific Utility of an Auxiliary International Language." The author publishes a letter by C. Meray, pointing out the many advantages possessed by Esperanto over previous systems, and mentioning that Esperanto is used by some 40,000 or 50,000 people already. The system, devised by Dr. Zamenhof, of Warsaw, is based upon the Latin languages, which have the closest relation to the scientific nomenclature of the present day, words and roots being adopted in proportion to the frequency of their international usage. The author presses the claim of the question to be considered by the International Association of Academies, and calls upon the French Academy to take the initiative. The adoption of an international "auxiliary" medium for scientific purposes would no doubt save an immensity of time and trouble. English speakers are fond of pressing the claims of their own language; but those claims are commercial rather than scientific. Italian has the strongest scientific claims, but as no nation is likely to give way to the other, the adoption of an artificial system, as in the case of algebra, seems the most rational solution. —H. Sebert, Comptes Rendus, April 9, 1901.

MAGNETIC THEORY OF THE SOLAR CORONA.—From a theory based upon Ebert's and Pupin's experiments on the behavior of a conducting body placed in a vacuum and subjected to magnetic force, F. H. Bigelow is led to conclude that the photosphere of the sun is the seat of powerful electric discharges which ionize portions of its material, or at least set free minute particles of matter charged with electricity. These are repelled outward in a coronoidal radiation, and give the forms seen in the disorganized streamers. This nucleus of the sun must be the seat of a powerful magnetic field whose axis is near that of the sun's axis of rotation, and whose action upon the ions repels them from the polar zones in accordance with Ebert's experiments. The equatorial regions of the sun usually show that there is a tendency to form a trumpet-shaped extension along the ecliptic, widening in proportion to the distance from the sun. This is another evidence of the fact of mutual electrical repulsion between the charged ions of like sign, since the spreading is similar to that of the cathode bundle in a vacuum tube.—F. H. Bigelow, Am. Jour. of Science, April, 1901.

EXCITERS FOR WIRELESS TELEGRAPHY.—In attempting to obtain the purest and least-damped waves, F. Braun (see also The Electrician, vol. xlvi., p. 778) hit upon two possibilities of compensating the damping of the oscillations by their own electromagnetic radiation. One of these consists in attaching the open exciter to a closed condenser circuit. Not only does the capacity of the latter reduce the damping by the spark, but it restores the energy radiated to the exciter. In the second device the exciter is quite detached, and represents an interrupted wire. Its lower end is twisted into a coil, and in this coil the oscillations of the primary condenser circuit are reproduced by induction. The exciter is then quite sparkless, but, all the same, amplitudes of potential variation may be produced in it of such magnitude as would be valueless if the exciter, with its small capacity, contained a spark-gap. Resonance between the primary and secondary circuits is very essential. Both methods give (1) nearly pure sine oscillations, (2) favorable radiation conditions, and yet (3) only a very slight damping. For long-distance work, the author believes these methods to be the best yet devised.—F. Braun, Phys. Zeitschr., March 23, 1901.

ACTION OF RADIUM RAYS UPON SELENIUM.—In 1899 Perreau discovered that the Roentgen rays produce upon selenium an effect comparable with that of light. E. Bloch has taken the further step of testing whether radium rays have a similar effect. One selenium cell tested was constructed in the manner of the old Siemens pattern, with a spiral trough between two metallic wires, and had an initial resistance of 30,100 ohms. It rapidly diminished by 800 or 1,000 ohms under the action of a feeble diffused light. Placed at a distance of 50 cm. from an incandescent lamp with ground-glass bulb it fell rapidly to 15,000 ohms, subsequently recovering very slowly in the dark. When a preparation of radio-active barium carbonate was brought within 1 mm. of it, with black paper intervening to cut off the light emitted by the preparation, the resistance slowly fell, attaining a value of about 29,000 in 10 minutes. On removing the radium preparation the resistance gradually increased again, reaching its initial value after about two hours. The radium preparation had an activity 1,000 times that of uranium, which is not much as modern attainments go. Another selenium cell had a resistance of 654,000 ohms, and this fell to 640,000 in 10 minutes, an effect which is about the same as that due to very feeble diffused light.—E. Bloch, Comptes Rendus, April 15, 1901.

GERMANY'S MACHINERY TRADE IN 1900.

THE German government has just published statistical returns on the foreign trade of the year 1900. It is gratifying to note that for the first time the imports and exports of machinery have been specialized; up to the year 1899 the various items in the machinery trade appeared as "machines of cast iron, of steel, of wrought iron," etc., so that it was impossible to obtain any accurate idea about the imports and exports of any specific line.

We gather from the official figures that the imports of machinery into Germany amounted in value to 77,664,000 marks, as against 64,712,000 marks in 1899. The exports of machinery were valued at 178,233,000 marks in 1900, as compared with 176,241,000 marks in the previous year. These figures refer to machinery proper, and do not include tools, instruments, ships and vehicles.

Analyzing first the import trade, we find that agricultural machines occupy the first place, their imports having amounted in value to 23,060,000 marks. Unfortunately, the imports from individual countries are not given by value, but only by weight. The respective figures, however, allow a comparison. The above mentioned 23,060,000 marks represented 28,825 tons of agricultural machinery, of which 20,249 tons came from the United States, 5,078 from Great Britain, 278 from France, 180 from Denmark, 169 from Sweden, 149 from Austria-Hungary, 135 from Switzerland, 129 from Belgium.

It will be seen that the United States stands far and away at the top in the trade of agricultural machinery.

The second largest item is occupied by cotton-spinning machinery, the imports having amounted to 10,863 tons, valued at 9,770,000 marks. Great Britain contributed 9,876 tons, Switzerland 612 tons, and France 232 tons. It seems that nothing was contributed by this country. We may here state that the demand for cotton-spinning machinery is growing all over the world. Many countries which up to the present time have imported immense quantities of cotton goods—to name only a few, Egypt, Turkey, Bulgaria, Greece—are now bending all their efforts toward the establishment of a cotton industry of their own. At the same time the demand for cotton-spinning machinery is increasing in Mexico, South America and the far East. It is to be regretted that the majority of our cotton machinery manufacturers are still working under the impression that "foreign trade" is not worth the trouble, as "no competition with Great Britain is possible." Germany and Switzerland know better. These two countries are building up a considerable foreign trade in cotton-spinning machinery. In 1900 Germany exported 4,599,000 marks' worth of them.

The imports of sewing machines were valued at 7,786,000 marks, chiefly from Great Britain and the United States.

Machine tools occupy the fourth place, the imports having amounted to 6,429,000 marks. This figure, however, does not include the following items, which are kept separately, namely: Steam hammers, 86,000 marks; machines for perforating and cutting metals, 304,000 marks. The 6,429,000 marks represented 6,270 tons of machine tools, of which 4,757 tons came from the United States, 588 tons from Great Britain, 338 tons from France, 259 tons from Austria-Hungary, 184 tons from Belgium, and 134 tons from Switzerland. In this item, too, the United States holds the first rank; of the 132 tons of steam hammers imported, 70 tons came from Great Britain. Other countries of origin are not mentioned. To the 553 tons of metal cutting and perforating machines we contributed 102 tons.

Locomotives and locomobiles (portable engines) were imported to the amount of 4,308 tons, valued at 4,110,000 marks. Great Britain's share was 3,196 tons (chiefly portable engines for agricultural purposes), while our share amounted to 189 tons. The rest came from Belgium, Austria-Hungary, and Switzerland.

The next item in order of importance is that of electrical machinery, the imports of which amounted in 1900 to 4,350 tons, valued at 3,915,000 marks. Our share amounted to 343 tons only, while Austria-Hungary's share was 2,080 tons, and those of Switzerland and Great Britain 977 and 239 tons respectively. Belgium contributed 401 tons and France 128 tons.

The imports of weaving machinery amounted to 8,184 tons, valued at 3,683,000 marks. Of these imports 6,138 tons came from Great Britain, 1,420 tons from Switzerland, and 251 tons from Austria-Hungary. Then come steam engines, with a total importation of 4,365 tons, valued at 3,273,000 marks, of which 1,738 tons come from Switzerland, 1,061 tons from Great Britain, 369 tons from Austria-Hungary, and 200 tons from the United States. Swiss-made steam engines, and especially those of Sulzer Brothers, of Winterthur, find a ready sale in Germany. The next items are of less magnitude; they include 1,249,000 marks' worth of lifting machinery, representing 1,666 tons, of which 574 tons came from the United States and the rest from Italy, Great Britain and Belgium; 888,000 marks' worth of blowing machinery (almost entirely from Belgium); 887,000 marks' worth of wool-cleaning machinery (Great Britain, Belgium and France); 844,000 marks' worth of flour-milling machinery, 1,055 tons, of which 182 from this country, and the rest from Switzerland (389 tons) and England (236 tons); 798,000 marks' worth of rolling mill machinery, almost entirely from Great Britain (473), with 77 tons from this country. 711,000 marks' worth of pumping machinery, chiefly from the United States and Switzerland; 278,000 marks' worth of paper and wood-pulp machinery (chiefly from Belgium, Austria-Hungary and the United States; 155,000 marks' worth of turbines (chiefly from Great Britain and Switzerland); power transmission machinery, 150,000 marks; 111,000 marks' worth of ventilating machinery (for workshops), chiefly from Great Britain and Switzerland; and brewing and distilling machinery to the value of 95,000 marks.

Then comes the great class of "unenumerated" machinery, representing 17,521 tons, valued at 13,140,000 marks. To this item was contributed: 6,466 tons by Great Britain, 3,577 tons by Belgium, 2,774 tons by the United States, 1,593 tons by Austria-Hungary, 1,180 tons by France, 900 tons by Switzerland, and the rest by other countries.

Turning to the exports of machinery, we find that the largest individual item is that of sewing machines, the exports of which amounted in value to 19,590,000 marks; Russia was the largest buyer. The second place was held by locomotives and portable engines, the exports of which amounted to 12,293 tons, valued at 14,751,000 marks. Russia was the best buyer, with 4,025 tons; then followed Austria-Hungary with 1,115 tons, the Dutch East Indies, with 1,054 tons; Norway (594), the Netherlands (550), France (495), Roumania (466), Spain (464), Belgium (448), China and Hong Kong (368), Switzerland (357), Denmark (333), Italy (303), Bulgaria, Great Britain, Sweden, Turkey, German Southwest Africa, Japan, Siam, Brazil, etc.

The third place was occupied by steam engines, the exports of which amounted in 1900 to 21,555 tons, valued at 14,011,000 marks. The best buyers were Russia with 5,586 tons, France with 4,247 tons, Great Britain with 1,889 tons, Belgium with 1,485 tons, Italy with 969 tons, Austria-Hungary with 935 tons, Holland with 886 tons; then follow Roumania (690), Switzerland (558), Spain (529), Sweden (329), the Dutch East Indies (269), Mexico (216), Denmark (183), Finland (127), Servia (86), etc.

In the fourth place comes electrical machinery, the exports of which amounted to 12,918 tons, valued at 11,626,000 marks. In this line, too, Russia was the best customer, with 3,077 tons. The second largest buyer was Italy with 1,829 tons, and the third Austria-Hungary with 1,197 tons. Then follow, in order of importance, France (1061), Great Britain (958), Spain (763), Belgium (608), Switzerland (430), Norway (408), Sweden (401), Holland (373), Denmark (218), Chile (238), Mexico (224), and Finland, Roumania, Japan, Brazil, Argentina, Dutch East Indies, etc.

Agricultural machines occupy the fifth place in the exportation of German machinery. Altogether, 12,955 tons, valued at 10,364,000 marks, were exported. Russia took more than half of the total exports, viz., 6,209 tons. The second best buyer was Holland with 1,087 tons. Then follow, in order of importance, Switzerland (990), Austria-Hungary (868), Belgium (781), France (636), Italy (489), Roumania (477), Argentine (284), Great Britain (167), Denmark (128), Norway (121),

* Compiled by E. E. Fournier d'Albe, in the Electrician.

Spain (100), and Chile, Paraguay, South Africa, Sweden, etc.

Machine tools occupy the sixth place, the exports having amounted to 9,267 tons, valued at 6,950,000 marks, but not including steam hammers, the exports of which amounted in value to 259,000, and metal cutting and perforating machinery, exported to the value of 894,000 marks. The best buyers of German machine tools were Russia (2,370 tons), Austria-Hungary (1,236), France (1,200), Italy (976), and Switzerland (964); then follow Sweden, Belgium, Denmark, Great Britain, Netherlands, Finland, Japan, Roumania, etc.

Rolling mill machinery was exported to the value of 5,047,000 marks, France, Russia, Belgium and Austria-Hungary having been the best buyers in this line. Four-milling machinery was exported to the amount of 6,107 tons, valued at 4,886,000 marks. The great bulk of this machinery went to Russia (1,219 tons), Austria-Hungary (723 tons), Norway (684 tons), France (524 tons), Belgium (520 tons) and Spain, Holland, Great Britain and Italy.

The exports of cotton-spinning machinery, which amounted to 4,599,000 marks, have already been mentioned. The largest customers were France, Russia and Austria-Hungary.

Machinery for the manufacture of paper and wood pulp was exported to the value of 4,395,000 marks, chiefly to Russia, Finland, Austria-Hungary, Italy, Great Britain, France, Holland, Sweden, Mexico and Spain. This item is followed by weaving machinery, the exports of which amounted to 3,924,000 marks, France, Italy and Austria being the best buyers.

Pumps and pumping machinery were exported to the amount of 5,709 tons, valued at 3,425,000 marks, chiefly to Russia (1,669 tons), Austria-Hungary (1,252 tons), France, Belgium, Holland, Roumania and Switzerland.

Then follows lifting machinery with 2,640,000 marks (chiefly to Russia, Holland, Argentina, Japan, Brazil, France, Italy, Norway, etc.).

The next item relates to beer brewing and distilling machinery, exported to the value of 2,349,000 marks, chiefly to Russia, Switzerland, Austria-Hungary, Holland, France, Great Britain, Sweden and Brazil.

Power transmission machinery comes next. The exports were valued at 1,162,000 marks, and the bulk went to Russia, Belgium, Austria-Hungary and France. Other more or less important items of the export trade are: Turbines, 695,000 marks (chiefly to Russia, France, Japan and Mexico); wool-cleaning machinery, 646,000 marks (chiefly to France and Austria-Hungary); ventilating machinery, 343,000 marks; and blowing machinery, 265,000 marks.

The exports of all other machinery amounted to 100,775 tons, valued at 75,581,000 marks, of which Russia took 13,278 tons, Austria-Hungary, 12,373 tons; Italy, 10,663 tons; France, 8,721 tons; Belgium, 7,066 tons; Spain, 6,324 tons; Switzerland, 5,636 tons; Holland, 5,561 tons; Great Britain, 4,404 tons; Sweden, 3,042 tons; Roumania, 2,975 tons; United States, 2,367 tons, etc.

The following table is a summary of the principal imports and exports during the year 1900.

	Imports, marks.	Exports, marks.
Agricultural machinery	23,060,000	10,364,000
Sewing machines	7,786,000	19,590,000
Cotton-spinning machinery	9,777,000	4,599,000
Machine tools	6,429,000	6,950,000
Steam hammers	86,000	259,000
Metal-cutting and perforating machines	304,000	894,000
Locomotives and locomobiles	4,110,000	14,751,000
Electrical machinery	3,915,000	11,626,000
Weaving machinery	3,683,000	3,924,000
Steam engines	3,273,000	14,011,000
Lifting machinery	1,249,000	2,640,000
Blowing machinery	888,000	265,000
Wool-cleaning machinery	887,000	646,000
Four mill machinery	844,000	4,886,000
Rolling mill machinery	798,000	5,047,000
Pumps and pumping machinery	711,000	3,425,000
Paper and wood pulp machinery	278,000	4,395,000
Turbines	155,000	695,000
Power transmission machinery	150,000	1,162,000
Ventilating machinery	111,000	343,000
Brewing and distilling machinery	95,000	2,349,000
Machinery, not elsewhere specified	13,140,000	75,581,000

H. L. G.

CAN THE ETHIOPIAN CHANGE HIS SKIN?

THE statement is made under sensational headlines in the daily press that Prof. Marshall Johnston, of the University of Kansas School of Medicine, has made some wonderful disclosures regarding albinos, to wit:

First, that an albino is merely the victim of a harmless disease, caused by germs.

Second, that the professor has seen and made cultures of the germs in question.

Third, that by appropriate inoculations of such germ-cultures he has converted ordinary animals into albinos.

Fourth, that he thus transformed a negro of the ordinary type into an albino, and in so doing gave him the color of a Caucasian, his eyes remaining unchanged.

Whatever may be the merits of the first three propositions above noted, the public will doubtless accept the last one with some degree of skepticism.

Unfortunately for the professor's theory, albinos are not uncommon among the negroes of the Southern States. A negro albino has a cadaverous-looking skin, nearly white, but quite different from the skin of a Caucasian. He has pink eyes, like any other albino. His eyes twitch nervously, and dance with a comical, jerky twinkle. Such a negro albino, Prince Morgan by name, was for several years foreman of a colored fire company at Meridian, Miss., and was seen by thousands of people.

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